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February, 1978
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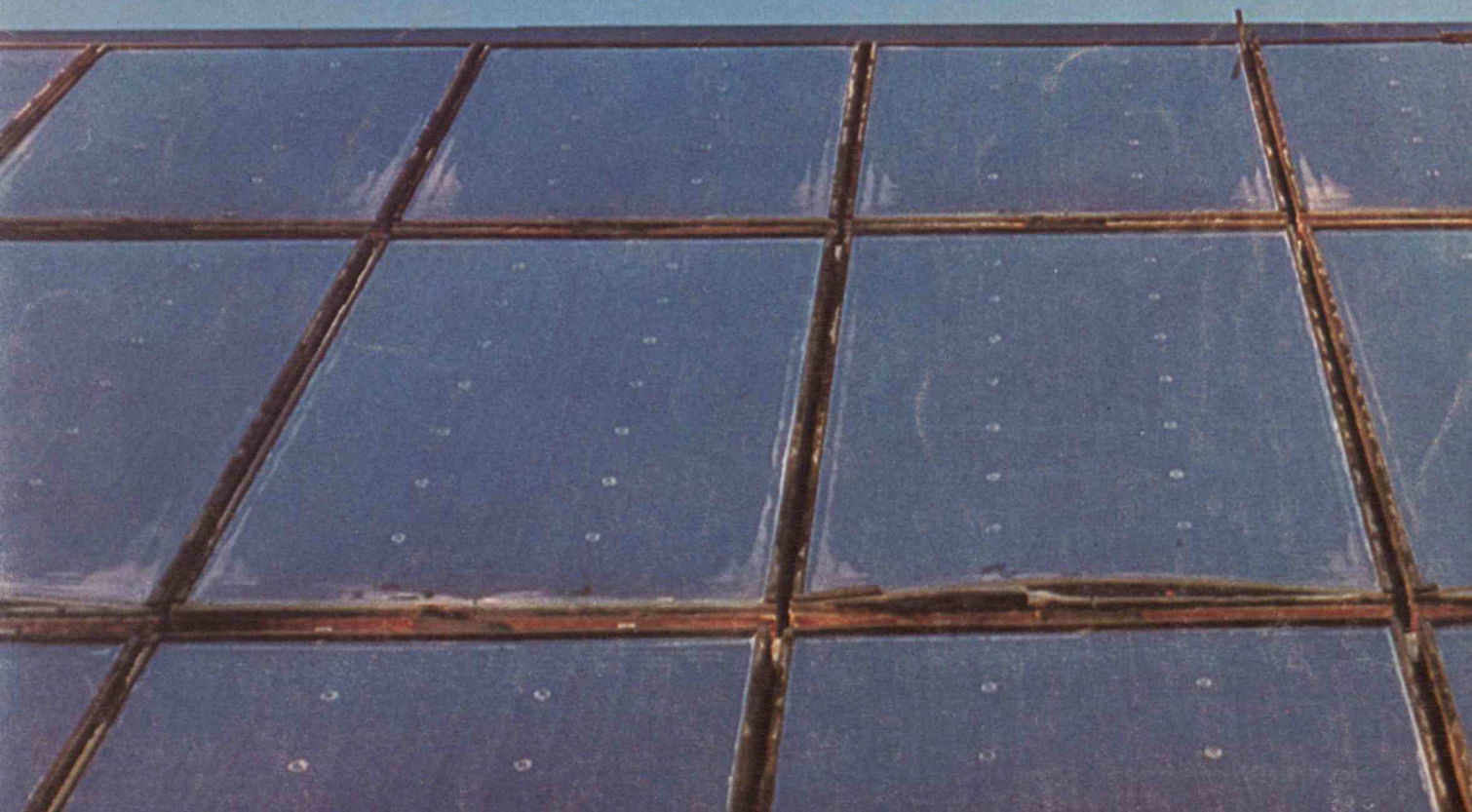
Lance Taylor et al on World Granaries

More on Innovation:
George R. White on Innovation Criteria
Innovator Robert N. Noyce on Innovation

Technology Review

Edited at the Massachusetts Institute of Technology

A Solar House for New England



technology
review
Published by MIT

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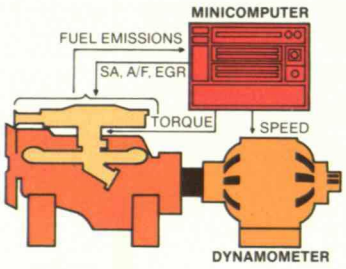
Up with mpg, down with ppm.

We wish that were the case... that raising a car's miles per gallon lowers its exhaust pollutant parts per million. But mpg and ppm don't seesaw. They tend to move up or down together, unfortunately.

Given that tendency and a fixed pollutant limit, how do you achieve good fuel economy in an automobile engine?



Electronics engineers here at the General Motors Research Laboratories are helping close in on the answer. They're doing it through an understanding of the dynamic interaction between spark advance (SA), air-fuel ratio (A/F), and exhaust gas recirculation (EGR) and how this affects fuel economy and emissions. Their goals have been to determine the optimum control strategies for the three variables and devise systems to implement these strategies.

By extending and applying microprocessor (minicomputer) technology and optimal control theory — the same kind of sophisticated theory used to control the descent of lunar modules — Lab engineers have:

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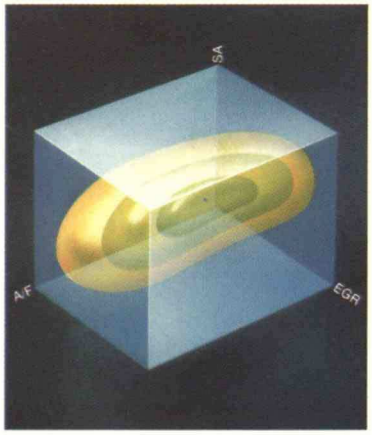

- Modified this system so that the computer makes the engine think it's in a vehicle, then drives the "vehicle" through federal schedules.
- Developed a unique computerized test facility in a station wagon to evaluate experimental control concepts in a real-world environment.

Not exactly a giant leap for mankind. Just three of the many determined steps we're taking on earth to push mpg up while holding ppm down.

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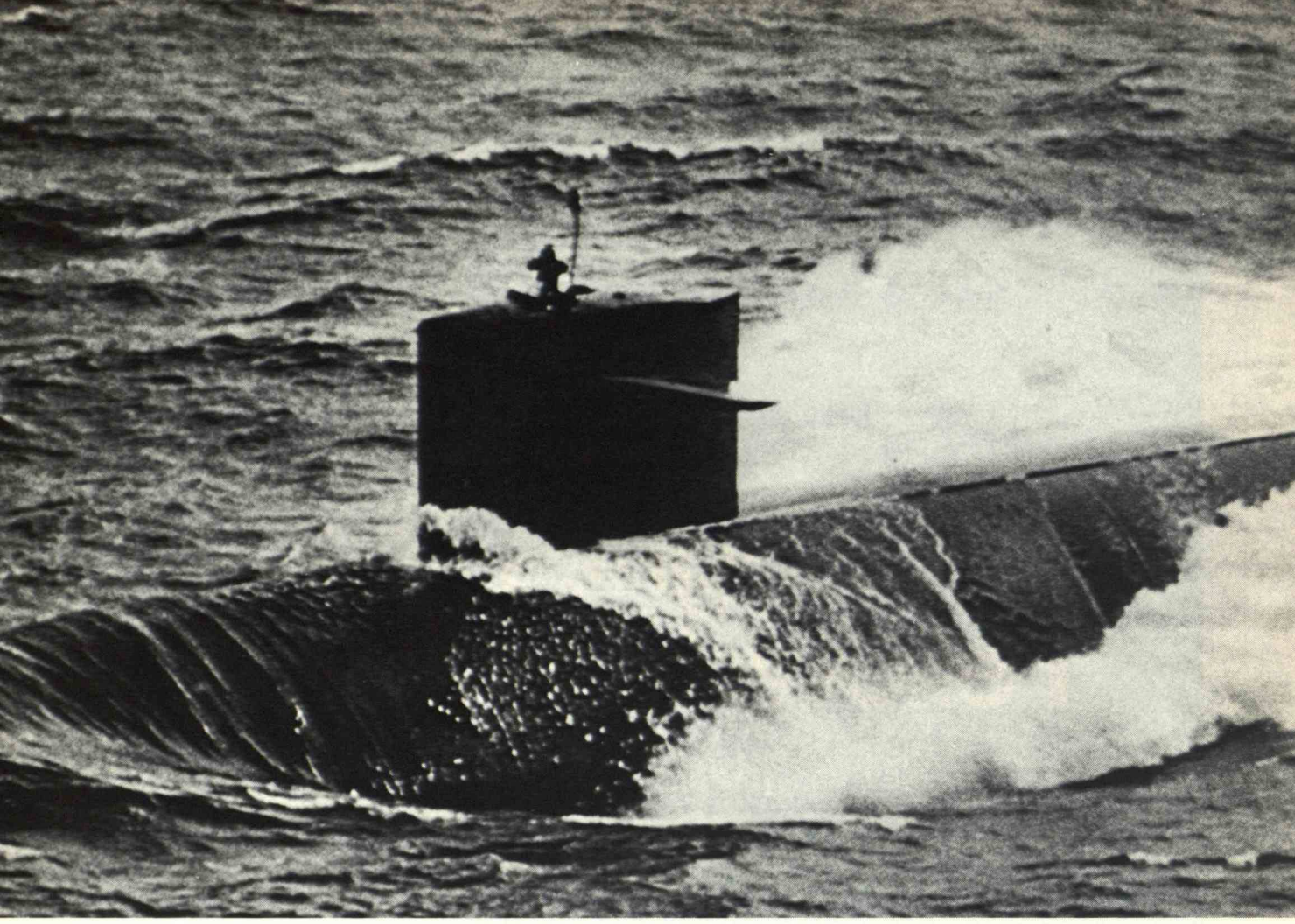

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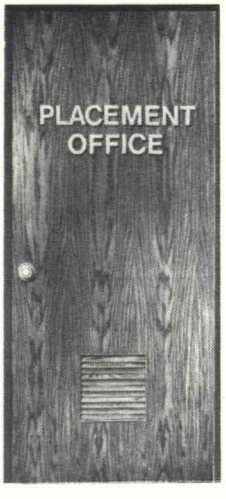

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5. *Mel D.* Field engineering. Appraisal load testing of low and medium-voltage switchgear and power transformers for utility and industrial applications.

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GENERAL ELECTRIC

An Equal Opportunity Employer

Edited at the Massachusetts Institute of Technology

Volume 80, Number 4
February, 1978

Technology Review

Technology Review, Reg. U.S. Patent Office, is published eight times each year (in October/November, December, January, February, March/April, May, June and July/August) at the Massachusetts Institute of Technology: three special editions are provided for graduate (pp. A1-A16) and undergraduate (pp A1-A16 and B1-B16) alumni and students (pp. A-H, A1-A16, and B1-B16) of M.I.T. Entire contents copyright 1978 by the Alumni Association of the Massachusetts Institute of Technology. *Technology Review* is printed by The Lane Press, Inc., Burlington, Vt. Second class postage paid at Boston, Mass., and at additional mailing offices.

Inquiries regarding editorial contents, subscriptions, and advertising should be addressed to: *Technology Review*, Room 10-140, Massachusetts Institute of Technology, Cambridge, Mass., 02139. Telephone area code (617) 253-8250. Unsolicited manuscripts are welcome, but no responsibility for safekeeping can be assumed.

Price: $2 per copy. Subscriptions: in the U.S., Canada, and Mexico — $15 one year, $24 two years, $32 three years; overseas $23 one year, $38 two years, $50 three years. Please allow three weeks for changes of address and give both old and new addresses in all requests.

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A report on a matter of public interest:

How the Bell System is pumping more service out of less oil.

In 1973, when the OPEC oil embargo went into effect, the Bell System committed itself to reducing its energy consumption. That commitment has been fulfilled. In four years, the Bell System has saved the energy equivalent of almost 24 million barrels of oil and over 415 million dollars in energy costs—savings that help hold down the cost of your telephone bills.

Today, the Bell System is actually using 11 per cent less energy than it did in 1973, even though the number of telephones in service has risen over 16 per cent and the volume of business has increased 33 per cent.

Here's how we are combining common sense with uncommon technology in four basic areas to achieve Zero Energy Growth.

Telephones are reconditioned three times.

The Bell System's energy needs begin with the power and fuel necessary to design and manufacture the basic communications components—cables, wire and equipment such as your home telephone.

In general, it takes much more energy to manufacture such items from scratch than it does to recycle them. Because Bell System equipment is designed by Bell Labs to be reliable, repairable *and* recyclable, extensive energy cutbacks have been realized through 40 years of recycling and reuse. New, more energy-efficient processes are constantly being devised by Western Electric, some of which entail modifying original designs for even greater materials and power savings.

Since 1974, the Bell conservation program has saved the energy equivalent of over three million barrels of oil by recycling metals. Also, more than six million equivalent barrels of oil have been saved through the reuse of equipment. The average telephone, for example, is reconditioned three times before it is unrepairable or obsolete.

New technology does more with less.

Another area in which the Bell System is effecting energy savings is in power for switching and transmission equipment. Constantly, new energy-saving technology is being added to the system. *Item:* Over two billion power-saving transistors, diodes and integrated circuits have been put into use. *Item:* Light Emitting Diodes (LEDs) are replacing incandescent bulbs in switchboards and telephones, saving over 90 per cent of the previously required power. *Item:* A new

microprocessor called MAC-8 is less than one-tenth the size of a postage stamp yet contains the equivalent of over 7,000 transistors. The MAC-8 can execute several hundred electronic "thinking" functions, yet it will operate on only one-tenth of a watt of power.

Smaller vehicles power giant fleet.

Twenty-two per cent of Bell's energy requirements are in fuel for its fleet of over 170,000 vehicles, the largest privately owned and operated motor fleet in the world. Here, a number of commonsense procedures have been adopted: engines are carefully tuned for peak efficiency, smaller and more fuel-efficient vehicles are being used, and shuttle services have been set up between some company locations. In addition, New York Telephone Company is experimenting with nonpolluting, energy-saving electric-powered trucks. Due to these and other efforts, the Bell System in 1976 used over five per cent less motor fuel than in 1973.

Even employees' body heat is used.

Heating, lighting and air conditioning of Bell System's 25,000 buildings account for 45 per cent of its energy needs. Broad economies have been achieved simply by removing thousands of unnecessary lights; by lowering temperature settings; by cutting back on hot water temperatures; and by heating or cooling unoccupied areas only to the extent required for equipment operations.

Moving beyond the obvious conservation measures, the Bell System created a building energy management program to redesign and retrofit existing buildings to improve their energy efficiency. Two examples of other power-saving programs at Bell facilities:

• On windy Block Island, Rhode Island, the New England Telephone Company began operating a wind dynamo in September, 1976. It can produce up to 15 kilowatts of electricity to power a central office and microwave radio terminal. Excess power from the windmill is fed back to the power company.

• In AT&T's new Basking Ridge, New Jersey, facility, an innovative computerized system heats about 1½ million feet of office space by recovering excess heat from the building environment—lights, equipment and the body heat of employees. It is estimated that the system uses 25 per cent less energy than conventional heating/cooling systems.

Bell trials of solar heating and cooling are providing valuable data which should lead to more widespread use of alternate energy systems.

Windmill helps power central phone office and microwave radio terminal (tower at right) on Block Island.

Today, throughout the Bell System, our commitment to energy conservation is more than a goal; it is an ongoing reality. And in looking to the future, we anticipate that in 1982 we will still be using no more energy than was used in 1973. *Keeping your phone system the best in the world.*

Bell System

In Praise of Motorcycles and Guns

I am appalled by Ian Nisbet's casual and unjustified inclusion of motorcycles with "handguns, cigarettes, [and] heroin" as products which should not be manufactured because they "cause damage which most people agree far outweighs their benefits" *("A Thrifty Man's Dilemma," July/August, p. 10).* We have created a society in which some form of personal, powered transportation is simply necessary for most people. To the detriment of our ecology, this need is currently met primarily by the automobile. Yet a great many motorcycles readily achieve 50 miles per gallon (and some a great deal more), while Detroit is struggling to make its four-wheeled living-rooms obtain half that figure. The motorcycle requires the least power to transport one or two people; it not only consumes less fuel than a car but also requires less road and parking space and fewer resources to manufacture.

Dr. Nisbet assumes that "most people agree" with his position, and therefore offers no justification for classing motorcycles with heroin. I must conclude that Dr. Nisbet holds a strong personal prejudice against motorcycles, which he is incapable of distinguishing from the realities of motorcycles versus cars.

Peter D. Wolfe
Cambridge, Mass.

I take rather strong exception to Ian Nisbet's lumping motorcycles with handguns, cigarettes, and heroin. I commute to work on a two-cylinder, four-stroke Honda CB175 in decent weather (dry roads, temperature 25°F. or higher). The trip is six miles each way and I consume less than a gallon of gasoline each week. In addition to fitting all Dr. Nisbet's criteria for frugality, ease of repair, and low environmental impact, my motorcycle is also a lot of fun.

Charles H. Marston
Berwyn, Penn.

Having been a member of the M.I.T. Faculty Pistol Team from 1948 through 1950, I must object to Ian Nisbet's derogation of handguns. The mental pressures and concentrations required for doctoral study in those years were relieved in the few hours a week I spent practicing and shooting in various matches. Since we could fire indoors in winter, this discipline and relaxation was available 12 months of the year.

Target shooters derive as much pleasure from their sport and strive for perfection as earnestly as the most dedicated golfer. From an environmental standpoint, land used for outdoor target shooting is often used for crop production except when shooting is underway. The effort of target shooters to stay in good physical condition and keep their nerves under control shows discipline which seems less prevalent now than in my generation. The people of Massachusetts disagreed with Dr. Nisbet's statement by a three-to-one vote last fall.

Louis J. Capozzoli, Jr.
Baton Rouge, La.

Dr. Nisbet responds:

In assessing the contribution of a technological device to social well-being, we must consider not only its benefits but also its costs. It would be happy indeed if handguns provided us with nothing but pleasurable recreation, motorcycles nothing but economical transportation, cigarettes nothing but soothing fragrance, and heroin nothing but temporary release from the stresses of life. Alas, all four also provide us with death, pain, suffering, and economic loss. My assertion that these costs outweigh the benefits is not made in haste or prejudice, but is based on careful judgment after study of the relevant statistics on deaths and injuries. Of course, I cannot be sure that "most would agree" with my position, but public opinion polls support me.

Cost-Free Research in Space

John Holt argues that a space colony of several thousands cannot be self-sufficient because on earth, self-sufficiency requires many millions of people *("Outposts of Progress," July/August, p. 12).* He ignores several facts. No nation has ever been completely planned in advance. No country has ever boasted a population so highly trained, free of redundancy, and working for a common purpose.

Mr. Holt maintains that space colonies would have to be repaired with the same regularity required for such earth-bound machinery as aircraft and submarines. But machinery does not suffer in zero-gravity and hard vacuum as it does under gravity and corrosive atmosphere on earth. Mr. Holt asks how it can be possible to make repairs outside a constantly spinning object. But in free fall, two objects traveling at the same speed and in the same direction will not move relative to one another. Mr. Holt discusses the technical problems and daily rigors of life in zero gravity. Having acknowledged that the colony will spin, Mr. Holt then ignores the effect of centrifuge.

A space colony could offer many highly specialized conditions for research which, while expensive to reproduce on earth, would be practically cost-free in a vacuum and free fall — services that could be sold or traded to terrestrial nations.

Cedric Braun
San Jose, Calif.

Mr. Holt responds:

It will not be possible to plan a space colony completely in advance; 90 per cent of what we learn about living in space will be learned from the effort itself — and many of these lessons will be expensive and painful.

Machinery does suffer in zero-gravity. According to Henry Cooper, who wrote a book about Skylab, it is already nonfunctional, many of its vital systems having broken down. We have already discovered that rotary bearings wear out very quickly in zero-gravity, perhaps because of the anomalous behavior of lubricants, perhaps because the shaft bumps rather randomly against the walls of the bearing rather than pressing at one point. In any case, much of the machinery will be within the artificial gravity system, and will wear out about as fast as earth machinery does.

The outside of a spinning body is not analogous to a body in free fall. A body in rotary motion must be constantly accelerated (by centripetal force) towards the center of rotation. What prevents me from flying off the surface of the earth is the gravitational attraction of the earth itself, for which there would be no counterpart on a spinning body in space.

Vague Notions

Edward Crawley's "Designing the Space Colony" *(July/August, pp. 44-50)* raises far more questions than I could even ask in limited space. Among them:

☐ If all that shielding is necessary, how are the people to be protected who build the colony? For how many hours could people survive in space without protection?

☐ What mechanisms would keep this spinning cylinder in dynamic balance? Without some such devices, the cylinder would tend to wobble in its rotation.

☐ Mr. Crawley speaks of a colony atmosphere of two-fifths of earth's atmospheric pressure. What is the longest period for which people, not to mention animals and plants, have lived in such an atmosphere?

Mr. Crawley's article shows that people are beginning to think about at least some of the hard problems of space. But the time schedule is wildly optimistic. Current technology lacks the means to do any of the things anticipated; what we have are vague notions of how we might go about doing them — which is a very different matter.

John Holt
Boston, Mass.

Mr. Holt's critique of space colonies appeared in the July/August, 1977, issue. — Ed.

Mr. Crawley responds:

Mr. Holt missed the main thrust of the article: that it is technically feasible to build the prototype colony within the suggested schedule and budget, provided the space transportation system and lunar mining operation can be built. As engineering students taking a one-semester course in M.I.T.'s Department of Aeronautics and Astronautics, with no budget and no computer time, we were best able

Continued on p. 65

The Power of Negative Thinking

Kenneth E. Boulding is a director of the Institute of Behavioral Science and Professor of Economics at the University of Colorado at Boulder. He is a regular contributor to Technology Review.

The power of positive thinking has innumerable advocates; nobody cheers for the power of negative thinking. Even within the benign purlieus of the peace research movement, negative peace — which is merely the absence of war — is decried. Positive peace — which is everything the heart desires — is applauded.

Positive thinking is part of our Christian heritage. The commandments "Thou shalt love the Lord thy God with all thy heart, with all thy soul, and with all thy mind" and "Thou shalt love thy neighbor as thyself" have been regarded as somehow superior to the remaining "Thou shalt not's." Today's popular morality, especially among the young, downplays the no-nos and plays up self-expression and self-realization — as if goodness were a flower that simply blooms once the restraints are lifted. We see the same attitude in the ideology and even theology of liberation; the assumption that all that is wrong with us in this world is the result of oppression and that once we are free, we will be transformed into a just, beautiful, and rich society.

Lemmings to the Cliff

I do not mean to rail against the positive altogether. There are profound positive forces in people and even in society that make our lives rich and that ought not to be suppressed. Pernicious oppression undoubtedly does exist. Our legal and moral structures are so fraught with prohibitions that they may prohibit activities which in fact are good and reasonable. One recalls an old joke about the difference between France and Germany: in France everything is allowed which is not prohibited, and in Germany everything is prohibited which is not allowed. The joke perhaps contributes to our impression that France is a little more cheerful and Germany a little more grim.

Nevertheless, the ideology of liberation seems to me only a very small part of the truth. I have argued that our objective function (as the systems people call it), or utility function (as economists call it), or goodness function (as I call it) — what goes up when things get better and goes down when things get worse — is more like a mesa than a Matterhorn. In the large area at the top of the mesa, freedom is highly desirable; there a variety of choices exists, none of them much better or worse than the others. So long as what we do does not matter very much, and choices are among almost equally attractive alternatives, freedom is desirable and restrictions absurd.

But the top of the mesa is bounded by cliffs. And society's "shalt not's" are the fences we erect to keep people from the cliffs' edges. Falling over the cliffs is the worst possible method of learning about them.

The trouble is that in the past we have built fences where there are no cliffs. This deception has given society's taboos their bad name — so much so that many people say no cliffs exist. All we must do is remove the fences, let everybody go where they will, and everything will be for the better. This seems to me a much too optimistic view of the world. The cliffs do exist and there are social processes which rush us over them if no fences stop us as we approach the edge. But identifying the cliffs (and deciding where to put the fences) is a difficult problem, especially if people do not come back after falling over them.

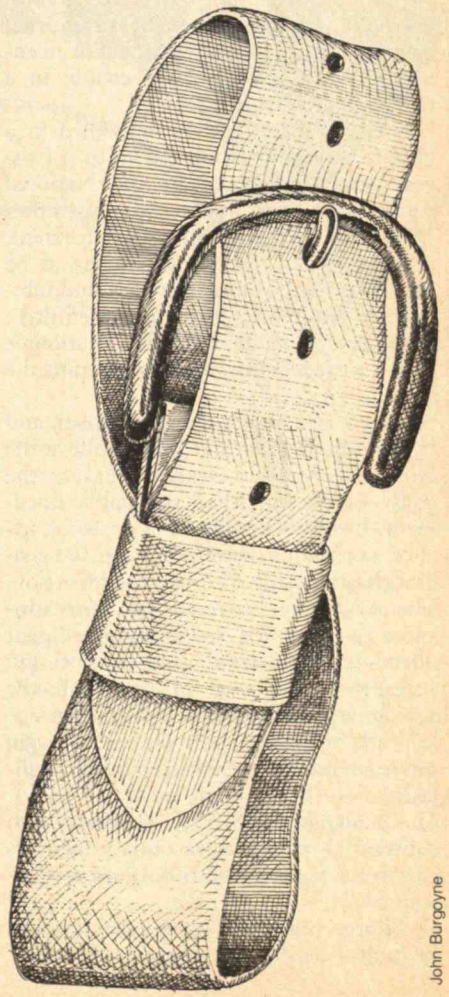
Virtue and Taboo

The importance of taboo has been very much underestimated by the present generation of social scientists. Taboo has been studied mainly by anthropologists; we think of it as something quaint and irrational in which anthropologists themselves would never indulge but which they observe in the interesting tribes that they study. This attitude has disguised the fact that taboo is an essential element of all societies, and without it they would fall apart. For any individual we can suppose a set of imaginable behaviors, divided into three fairly discrete subsets: the impossible; the tabooed (whatever is possible but illegitimate); and the possible and legitimate. In the first set are things we cannot do, in the second are things that we do not do (although we could), and in the third are things we can and will do.

The impossible is divided from the possible by what economists call a "possibility boundary." And within the realm of the possible, tabooed activities are distinguished from legitimate enterprises by what can be called the "taboo line." The position of the taboo line is an enormously important variable of social systems, and it varies within a society, as well. The difference between peace and war, for instance, is almost wholly defined by the position of the taboo line; in war that line is pushed out, so that we can bomb cities and invade boundaries, as we would never do in peace. The conventions of courtesy also involve a taboo line — the innumerable eyes into which we could but do not spit. Law is largely the formalization and penalizing of taboos. Law very rarely bribes us to do right; instead, it usually penalizes us when we do wrong. Law is the institutionalization of negative thinking.

The argument that we have had too much of negative thinking is persuasive. Psychologists tell us that rewards are more effective than punishments in changing behavior. Parametric planning by ma-

Continued on p. 55



John Burgoyne

Close Encounters of the First Kind

Robert C. Cowen, Science Editor of the Christian Science Monitor, *writes regularly for* Technology Review. *He is former president of the National Association of Science Writers.*

Humanity may someday find the electromagnetic equivalent of a note in the bottle: a radio signal from another civilization that says, in effect, "you are not alone." It could be what Cornell University radio astronomer Frank Drake calls "a great turning point" in our development. It would enhance our understanding of our place in the cosmos and open a portentous new channel for knowledge. Such is the faith that drives S.E.T.I., the Search for Extraterrestrial Intelligence. Its expectation of an epochal payoff compensates for the ennui of an enterprise with less than one chance in a million billion of success.

Now S.E.T.I.'s faith is embodied in a plan for national action drawn by a two-year study sponsored by the National Aeronautics and Space Administration (N.A.S.A.). Whether, or to what extent, the plan will be adopted remains to be seen. But the document itself is undoubtedly a landmark: the most definitive statement yet made of S.E.T.I.'s rationale and of a practical strategy for pursuing the search.

Edited by M.I.T.'s Philip Morrison and by John Billingham and John Wolfe at the N.A.S.A. Ames Research Center, the study will be published as a public document. It draws heavily on a series of science workshops organized under the general chairmanship of Professor Morrison. The workshops covered the well-cultivated ground for believing intelligent aliens exist, assessed our present and foreseeable capacity to carry on the search, and reached four conclusions:

☐ "It is both timely and feasible to begin a serious search for extraterrestrial intelligence."

☐ "A significant S.E.T.I. program with substantial potential secondary benefits can be undertaken with only modest resources."

☐ "Large systems of great capability can be built if needed."

☐ "S.E.T.I. is intrinsically an international endeavor in which the United States can take a lead."

People with long memories may find these merely warmed-over conclusions of past S.E.T.I. studies. But the earlier, less extensive analyses tended to be visionary. This time, the analysts have striven to be hard-nosed and practical about a subject that is inherently romantic. A 1971 N.A.S.A. summer study made a publicity splash by recommending Project Cyclops: an array of 1,000 or more large radio telescopes to be deployed over an area as much as ten miles across, and costing $6 to $10 billion over a 10- to 15-year period. While the scheme has been a great conversation piece, no one expected the Office of Management and Budget to let N.A.S.A. buy any substantial part of it. In contrast, the present plan would start modestly and move on to grander strategies only as they became justified.

Informed Opinion

Improved data processing could boost a radio telescope's sensitivity for S.E.T.I. a thousandfold. Both ordinary radio astronomy and S.E.T.I. research could benefit from multichannel analyzers that could search quickly through thousands or millions of frequencies. It might cost $200,000 to upgrade a radio telescope in this way. Then that telescope could be used part-time for S.E.T.I. work. At a cost of only $1 million the first year, rising to $3 million over the next two to three years, Dr. Billingham says we can make a good start on a nationally coordinated program of this kind. Only if this modest effort failed to turn up anything would S.E.T.I. appropriate a few existing radio telescopes for a full-time search. And only if this stepped-up effort also failed would development of costly giant systems such as Cyclops or an orbiting listening post be urged. At every stage, the study predicts solid gains for radio astronomy's deeper probes of astronomical objects and space — whether an alien signal turns up or not.

Thus the S.E.T.I. analysts are not asking for commitment of major resources to an uncertain enterprise. They ask only modest but sustained support for a carefully-phased program that conceivably could return the most exciting evidence of any scientific project ever undertaken.

Explaining why they think an alien signal might be intercepted, the analysts frankly admit they are dealing with informed opinion, not established knowledge. Yet they do give substantive reasons for the swing of opinion to a pro-S.E.T.I. view. "Only a few decades ago," the report notes "most astronomers believed that planetary systems were extremely rare and the habitat for life that earth provides might well be unique in the galaxy. No serious program for detecting extraterrestrial intelligence (E.T.I.) could arise in such an intellectual climate." That skepticism has eroded as biologists have learned more about life on earth. In particular, the report points out, "Life appears to have developed on earth almost as soon as seas had formed and chemical evolution had provided the building blocks. Earth has been lifeless for only a fraction of its age. This leads many exobiologists today to look upon life as a very likely development. . . ."

The aliens would not necessarily look like us. Mark A. Stull of Ames explains: ". . . different evolutionary pathways cannot be expected to produce identical results. It is not unlikely that technological species are abundant in our galaxy, but [it] is very unlikely that elsewhere we will find men."

A Million Billion Straws

Faith in the ubiquity of life doesn't guarantee that we will discover alien civilizations. A long careful search may convince scientists that, for practical purposes, humanity is indeed alone. The study sees no loss in this conclusion; it would drive home the point that our life-bearing planet is a precious jewel to be cherished and conserved. "On the other hand," the report says, "were we to locate but a single extraterrestrial signal, we would know immediately one great truth: that it is possible for civilization to maintain an advanced technology and *not* destroy itself. We might even learn that life and intelligence pervade the universe."

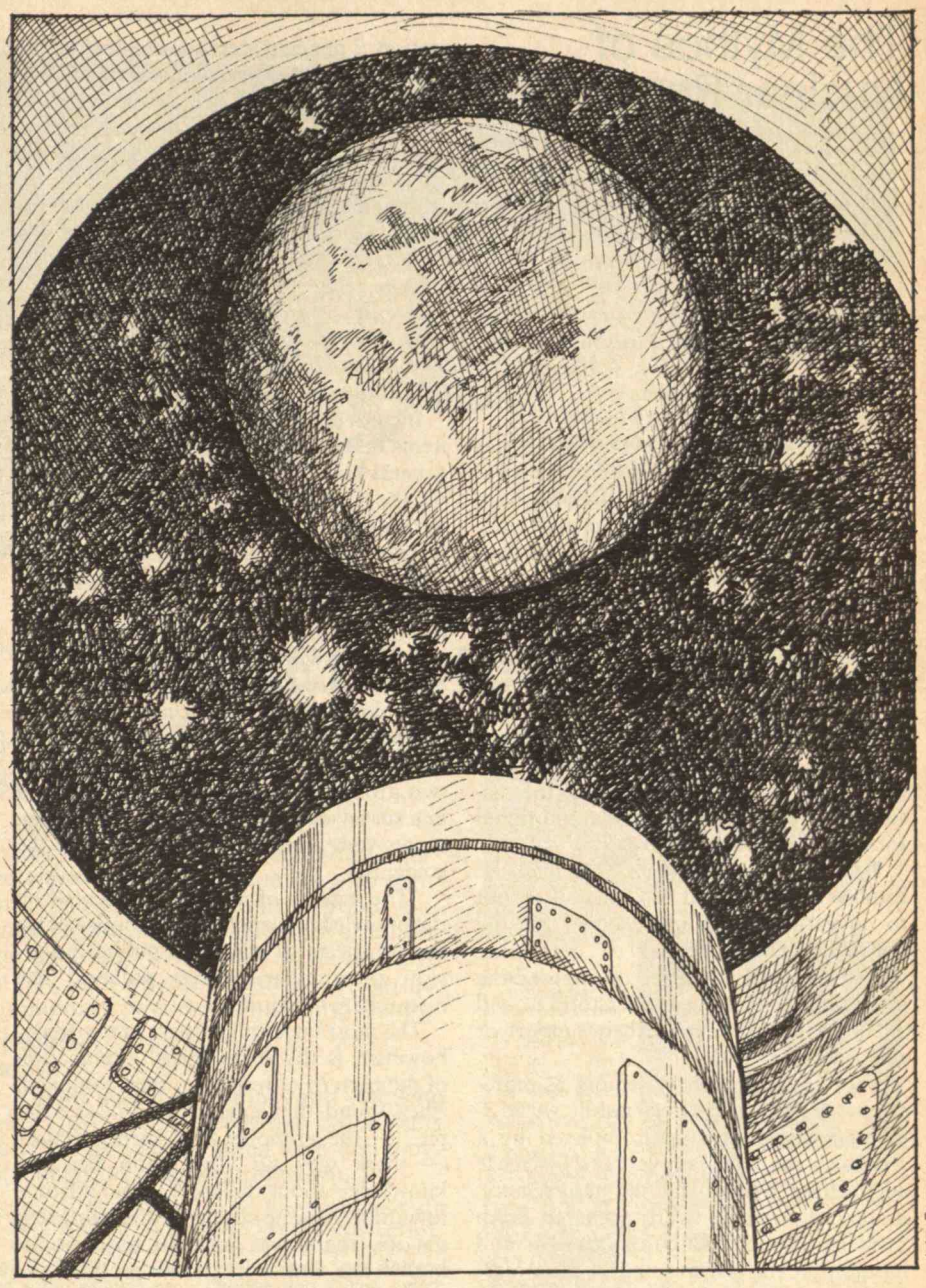
Skepticism must be the rule in searching for such a discovery, the report warns. Stringent verification standards must be maintained to "escape the volatile raising and dashing of great hopes."

If we do make the search, an intimidating question remains: how can we best look for the proverbial needle in the haystack? Frank Drake estimates that there are 40 million different directions to look in the sky, and on the order of 100 billion frequencies to be scanned. Given these numbers and other relevant constraints such as antenna sensitivity and radio wave scattering in space, Dr. Drake estimates there are over a million billion straws in the hay pile to be sorted in search of the needle.

Is there any rational way to narrow down this search? One strategy which the S.E.T.I. study emphasizes is to narrow the

frequency scan to a region dubbed the "water hole." The band is from 1400 to 1727 megaHertz (MHz) and is marked by the characteristic frequency of hydrogen (1420 MHz) on the low end and of the hydroxyl radical (1662 MHz) near the high end. This band minimizes the combined interference from galactic background noise, receiver noise, and atmospheric absorption. It also features the two constituents of the water molecule. Hence the Cyclops team in 1971 named this band the "water hole": "... these two emissions of the ... products of water beckon all water-based life to search for its kind at the age-old meeting place of all species: the water hole."

"It is easy to dismiss this as romantic nonsense, but is it?," observes former Cyclops study leader Bernard M. Oliver. However chauvinistic the assumption, water-based life may indeed be typical. Dr. Oliver adds, "Romantic? Certainly. But is not romance itself a quality peculiar to intelligence? Should we not expect advanced beings elsewhere to show such perceptions? In the absence of any more cogent reason to prefer another frequency band, we suggest that the water hole be considered the primary preferred frequency band for interstellar search," he says. To this end, the S.E.T.I. report also urges the 1979 World Administrative Radio Conference to give the water hole frequency band special protection so that navigation satellites and other would-be users of those frequencies will not clutter this cosmic communications channel.



John Burgoyne

Are We Alone?

As with all great commitments, there are dissenters. One minority argues that if life is in fact omnipresent, we should have intercepted it already. Michael D. Papagiannis of Boston University, for example, says that star travel is so easy that the whole galaxy would be colonized by now if other civilizations exist. In the May, 1977, issue of *Science,* T.B.H. Kuiper and M. Morris of the California Institute of Technology proposed that large, self-sufficient space colonies could drift to other star systems at a few per cent of the speed of light, crossing the galaxy in a few million years. Where are they, then? asks Dr. Papagiannis. They may be keeping themselves discreetly hidden, he says, but more probably, we are alone.

Most S.E.T.I. enthusiasts are skeptical of this rebuttal because of the long periods and vast energies that star travel requires. Dr. Drake, for example, thinks such colonies would be too costly to interest even a highly advanced technology. Dr. Drake does have new doubts of his own about the search strategy. Are there radio frequencies other than those of the water hole that might stand out as radio beacons? Are any frequencies uniquely defined by physical laws that entail no assumptions as to biology? Given fundamentals such as scattering and absorption by space dust and basic antenna parameters, he can find such frequencies, often far removed from the water-hole band. Thus he suggests that there are no compelling arguments for preferred frequencies; he urges S.E.T.I. to search all frequencies — and look in all directions.

Both skeptics such as Dr. Papagiannis and enthusiasts such as Frank Drake (who conducted the first S.E.T.I. 20 years ago) agree that the question of whether alien intelligence exists should be answered. If we detect that long-sought signal, it could open "the next stage in the evolution of hominids," says Dr. Stull. And if on the other hand we are finally convinced no one is out there to talk to, we would awaken to "quite a responsibility," says Dr. Papagiannis. We would know then that "we are the torch bearers of the flame of cosmic consciousness in our entire galaxy." How can we lose? □

The Mythos of Nuclear Power

David F. Salisbury, who reports on science for the Christian Science Monitor *from its West Coast Bureau, is a regular contributor to the* Review. *He studied physics at the University of Washington (B.S. 1969).*

The legal and political battle which has embroiled the nuclear industry is similar to the clash between rival religions. Both sides claim to have the revealed truth. And both characterize their opponents as irrational, misled, even evil.

One of the tenets of the debate over nuclear power is that an "informed" public will reach the proper conclusion for this emotion-laden issue. However, an in-depth study of the views of University of Tennessee (U.T.) seniors regarding the nearby Clinch River Breeder Reactor (C.R.B.R.) project contradicts the assumption and illuminates the emotional roots of this vital controversy.

Two U.T. sociologists, Michael D. Bremseth and Donald A. Clelland, set out to investigate public reaction to the C.R.B.R. They wanted to determine whether people supported or opposed the project, how well they understood it, and what the bases were for their support or opposition.

They chose university seniors as representative of the educated public. A 215-item questionnaire was completed by a stratified random sample of 94 science engineering majors and 91 non-science majors. Responses were gathered from January through March of last year and reported at the last meeting of the American Sociological Association.

Knowledge and Belief

"We really didn't expect anything surprising," say the researchers. Their hopes were pinned on a companion study of civic leaders. But their expectations were confounded by sharp contrasts among the students surveyed.

Thirty five per cent of the non-technical majors favored nuclear development, 29 per cent were unsure, and 36 per cent opposed the project. Of the science majors, 59 per cent favored nuclear development, 15 per cent were not sure, and 27 per cent were opposed. Eighty-six per cent of the engineering students backed the nuclear option, 2 per cent were unsure, and 12 per cent opposed it. This compares to a Harris poll in August, 1975, which found that 63 per cent of the public favored nuclear power development, 18 per cent were unsure, and 19 per cent opposed it.

When asked specifically about the breeder reactor, there was little distinction drawn by engineering and non-technical majors, the researchers found. Surprisingly, however, they discovered that science majors supported breeders considerably more than conventional nuclear power plants.

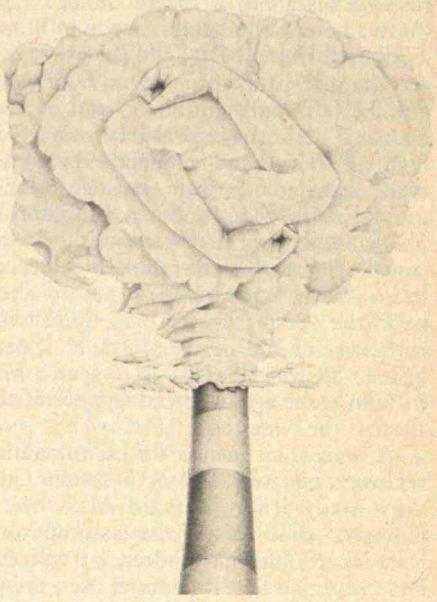
Included in the questionnaire were items designed to determine the extent of general knowledge pertinent to a decision on the C.R.B.R. And the students' performance was extremely low. The technical majors, of course, scored somewhat higher, but even here only 14 per cent answered more than half the technical questions correctly and only 34 per cent answered more than half the general knowledge questions correctly. When the "don't know" responses were discounted, however, the ratio of correct to incorrect answers was the same for the two groups. (On five questions also used in a survey of public leaders in Wisconsin, scores were even lower than those of the students.)

"The pattern of responses indicated on the knowledge items certainly bodes ill for the prospects of reasoned public discussion of nuclear energy policy," the researchers conclude.

The most unsettling aspect of the study, however, is the sociologists' explanation of the pattern of responses they compiled. They found that among the "mass sample" — the group of non-science majors — there was no correlation between knowledge about the breeder and attitude toward it. Among science and engineering majors, there was a slight association: knowledge was a moderate predictor of support.

Among the non-technical students, concern over safety was found to be the major source of opposition to the breeder reactor. And for the same group, belief in safety was the most frequent reason for support. Safety accounted for fully 45 per cent of opinion in favor or opposed. Among technical majors, safety accounted for less than 15 per cent of opinion on the reactor. "Apprehensions about safety, then, do not have the overriding impact among the technically trained which they have among other students," the researchers find.

Two general attitudes were clearly manifest among both technical and non-technical majors: trust in energy agencies and trust in environmentalists. Trust in environmentalists seemed to encourage opposition and to shape beliefs concerning safety. Similarly, trust in energy agencies encouraged a favorable opinion of the breeder reactor and among the technical majors, almost predicted belief in its safety.



Carol LaCourse

The fact that a number of variables had little or no predictive weight is also significant. Concern over disagreement of experts, lack of public involvement in nuclear development, escalating research and development costs, pollution, and the long-term energy situation made little difference in opinion. Also immaterial were grade-point average and sex of the respondent.

Promethean Flame, Mechanical Demon

Despite the claims of both proponents and adversaries of nuclear power that their stands are based on fact and reason, the strength of the emotions surveyed in the U.T. study suggest that strong subconscious forces are at work. A persistent mythological and religious theme is destruction and restoration. The unconscious application of this ancient archetype to nuclear power may account for the intense feelings provoked.

Commercial nuclear power is an outgrowth of the "Atoms For Peace" program. From the destructive force unleashed on the world in the form of the atomic bomb, American engineers attempted to forge a plentiful and inexpensive energy source. The atomic bomb,

Continued on p. 55

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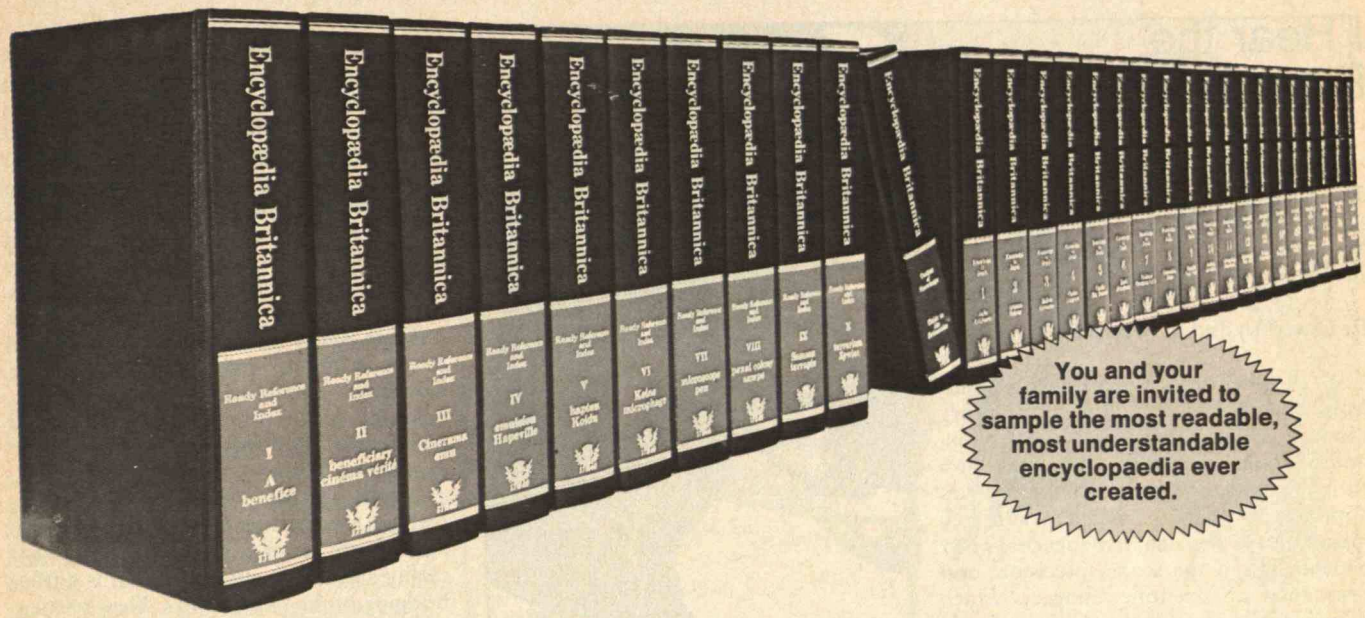

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I Hear the Planets Singing

The Planets, A Cosmic Pastoral
Diane Ackerman
New York: William Morrow and Co., Inc., 1976, 159 pp.; $6.95

Reviewed by Judith Wechsler

The 17th-century metaphysical poets, Marvell and Donne, and the 19th-century romantic poets, Wordsworth, Emerson, and Thoreau, felt at ease with nature as a subject for poetic expression. Nature was a principal source of imagery and rich metaphor for personal experience. Poetry benefited from the scope, precision, and resonance of scientific imagery which honed experience while ringing cosmic overtones. In our time, the idiosyncracy of poetic experience — the ambiguities and personal references on the one hand, and on the other, a concern for the genre's intrinsic formal properties — have led to a general neglect of nature and scientific ideas and images.

Diane Ackerman's *The Planets, A Cosmic Pastoral* revives the tradition of grand unity. These poems are in turn forceful and whimsical descriptions of physical reality and the "character" of the planets. In "Earthshine," Ms. Ackerman assigns these snappy attributes: "I think [. . . .]/of gangrene Uranus, ghoul of the heavens,/of Pluto, rock-ribbed as a die-hard comet."

Mercury is sinister: ". . . . a target gone berserk/in a shooting/gallery."

Venus exudes sexual associations:

Cleopatra in high August –
her flesh curling
in a heat mirage
light years
from Alexandria:
No sphagnum moss
or polypods fern here,
where blistering vapors
and rosy bile
hint at the arson
with which the Universe began.

The words appear in rhythmic splay upon the line. Again, from "Venus,"

The pearly tonnage
swinging
like a giant compass
newly risen to our iron heart.

Renée Klein

Other observations. For instance, in the poem "Earth," we discover a spicy catalogue of animals and plants; an underwater venture; an E. coli infection in florid terms "and all the fauna of my disregard."

"Mars" is a play on the earthly place, space, state, and person names given to areas of the planet. Fantasies are spun out in a cosmic space of familiar terms:

we'll dream ourselves – a gallop
this side of Tranquility, just
beyond Utopia and through the
Martian moors.

The poems on Neptune are licentious, erotic, even bawdy. "Uranus," a play, is a hilarious satire, a raucous symposium of physicists past and present, in which Ms. Ackerman also parodies her own work. The poet does not pretend to more than a rich sense of wonder at science: "on the run through hyperbola, parabola or ellipse/I'm bone-deaf to cloud-chamber music."

Her tone is frank, almost confessional about expectations and limitations as she seeks form for experience in its cosmic correspondences. She projects a two-way exchange, seeking wordly equivalence in images of astrophysics and imposing a personal warp on cosmic phenomena:

Perhaps I've had too much at stake
on these cryptic Petri dishes orbiting
the Sun. If nothing's afoot here
but dumbbell, loveseat, and oarlock
craters,
hotbed simmon and marmoreal dust,
in which clinic will my dashed
hopes renew?
[. . . .]
I'm young as I write this and green
yet in my lifetime we'll never sail
beyond Pluto, or cut time
on the bias in a black hole in space . . .

There is a youthful exuberance to these poems, a lilting, witty, sensuous, at times wondrous cosmic meander sung like the pastoral of its title. Ms. Ackerman's poems exhibit a fluency of images and evocations at once scientific, mythological, and personal. Nature is her mirror and her measure. Her use of scientific imagery both as an expression of physical reality and imaginative metaphor is a true bridging of the two cultures. Here science and art naturally enhance one another and the language of science is reclaimed for poetry without loss of the poet's own voice.

Judith Wechsler is an art historian and a Fellow at M.I.T.'s center for Advanced Visual Studies. She is editor of Aesthetics and Science *to be published by M.I.T. Press next year.* □

The Social Factor in Earthquake Hazards

Earthquake and Tsunami Hazards in the United States: A Research Assessment
Robert S. Ayre
Boulder: University of Colorado, Institute of Behavioral Science, 1975, xxii + 150 pp.; $5

Reviewed by Robert V. Whitman

Here in Boston one hears a confident bravado: ". . . have lived here for 25 years and haven't felt a tremor. . ." But where were such speakers in the fall of 1963, when we did in fact experience a minor earthquake? And have they never read about the earthquake of 1775, whose chroniclers used the word "major" — though no one was killed.

Clearly some way must be found to paint a reasonable and understandable picture of earthquake risk. The loss simulations described in some detail by Dr. Ayre are one effort in this direction — an

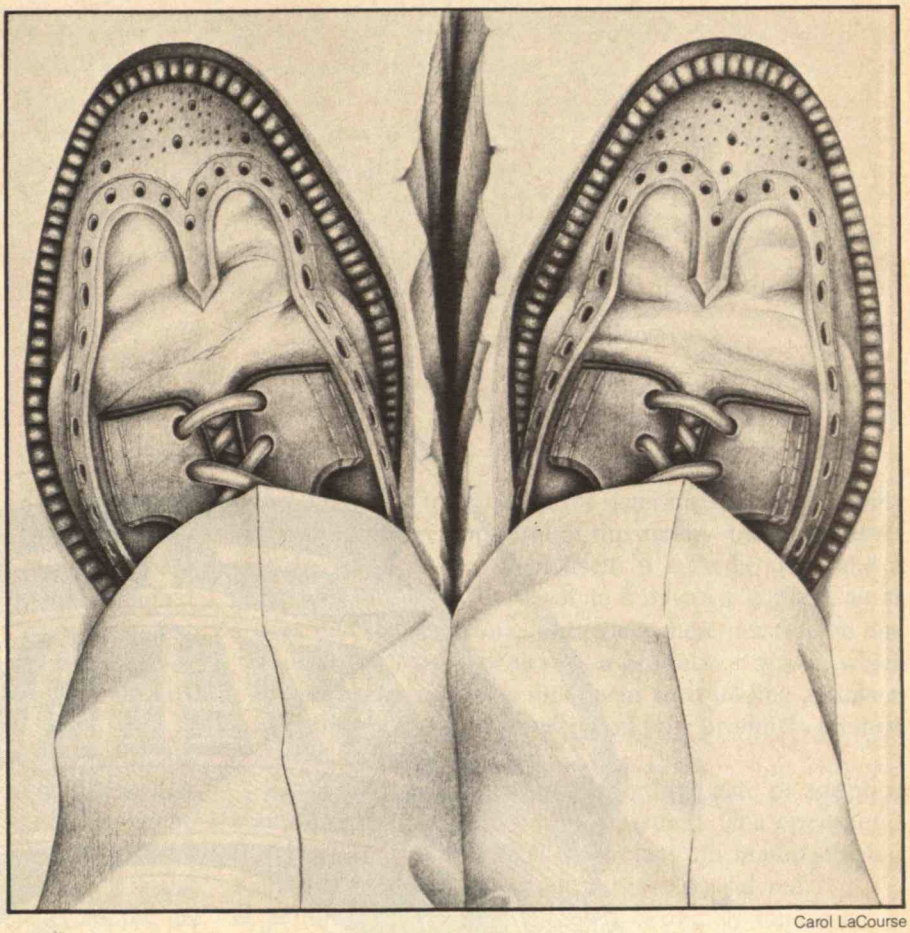
attempt to show how changes in building practice would affect the losses due to earthquakes of various intensities. I myself have been engaged in developing data on the susceptibility of buildings to earthquake-induced damage or failure, and I have sought computer models to link the knowledge of seismologists and engineers. Much more needs to be done: we need ways to make better loss estimates for hypothetical earthquakes and to help building officials and others to understand the usefulness of this tool.

Modest Proposals

Dr. Ayre's book is a good start. The study which led to it was part of a larger inquiry, *Assessment of Research on Natural Hazards* by Gilbert F. White and J. Eugene Haas (M.I.T. Press), intended to provide "... a more nearly balanced and comprehensive basis for judging the probable social utility of allocation of funds or personnel to various types of research on natural hazards." In its early stages, the project held out the hope that its final recommendations might result from a systematic, quantified analysis of the costs and benefits of various research undertakings. Indeed, scenarios were prepared, loss simulation studies performed, and some cost/benefit calculations made.

However, a sound scientific basis for such studies was lacking and participants were unsure how to utilize the analyses' results. In the end, the project relied upon the judgment of project personnel and consulting "experts" (including the reviewer) to rate types of research subjectively according to their economic efficiency, reduction of casualties, avoidance of social disruption, enhancement of the environment, equity in the distribution of costs and benefits, and ultimately, expected success and likelihood of adoption.

The final recommendations took the form of suggested — and one would have to say modest — levels of funding for various general types of research. With regard to earthquakes, the recommendations implied that funds for technological research — earthquake prediction, strengthening buildings, etc. — should be maintained or modestly increased, but that funding for research into "... the all important social, economic, and political 'people' factors involved in hazard reduction..." should be greatly increased. In short: "New emphasis needs to be infused in the nation's research effort to balance attention to technological solutions with attention to social measures."



Carol LaCourse

Toward a National Program

The tone of the conclusions is not surprising given the credentials of the principal investigators for the overall project. Gilbert White, among his many accomplishments in the field of geography, had undertaken studies of adjustments to the hazard of floods and had been highly critical of heavy reliance on the technological solution of building dams and levees. Eugene Haas, a sociologist, had conducted studies of community response to disasters. While engineers and scientists were involved in the project as participants and consultants (Dr. Ayre himself is well known for his research into the dynamic behavior of buildings and mechanical systems), the biases of the project personnel are evident. Actually, earthquakes are among the few hazards for which technological solutions are given high marks.

Those of us concerned with earthquake prediction and engineering do need to be concerned with "... the factors which lead to non-adoption of technological findings, or which indicate that proposed steps would not work or would tend to perpetuate or increase the problem." If this book falls short, it is in not being specific enough about needed research into economic, social, and political influences. The book does not make the mistake of defining such tasks as writing preparedness plans as research. Even so, it is clear that research does not mean quite the same thing to a social scientist as to a seismologist or structural engineer.

Dr. Ayre's book was written when no coordinated national program existed to deal with earthquake hazard. Since then, such a program has been formulated (in 1976) by a working committee assembled by then-Presidential Science Adviser Guy Stever. The committee's report calls for a broad effort in both the physical and social sciences, and also for efforts to speed the adoption of research findings into practice.

Robert V. Whitman is Professor of Civil Engineering at M.I.T. □

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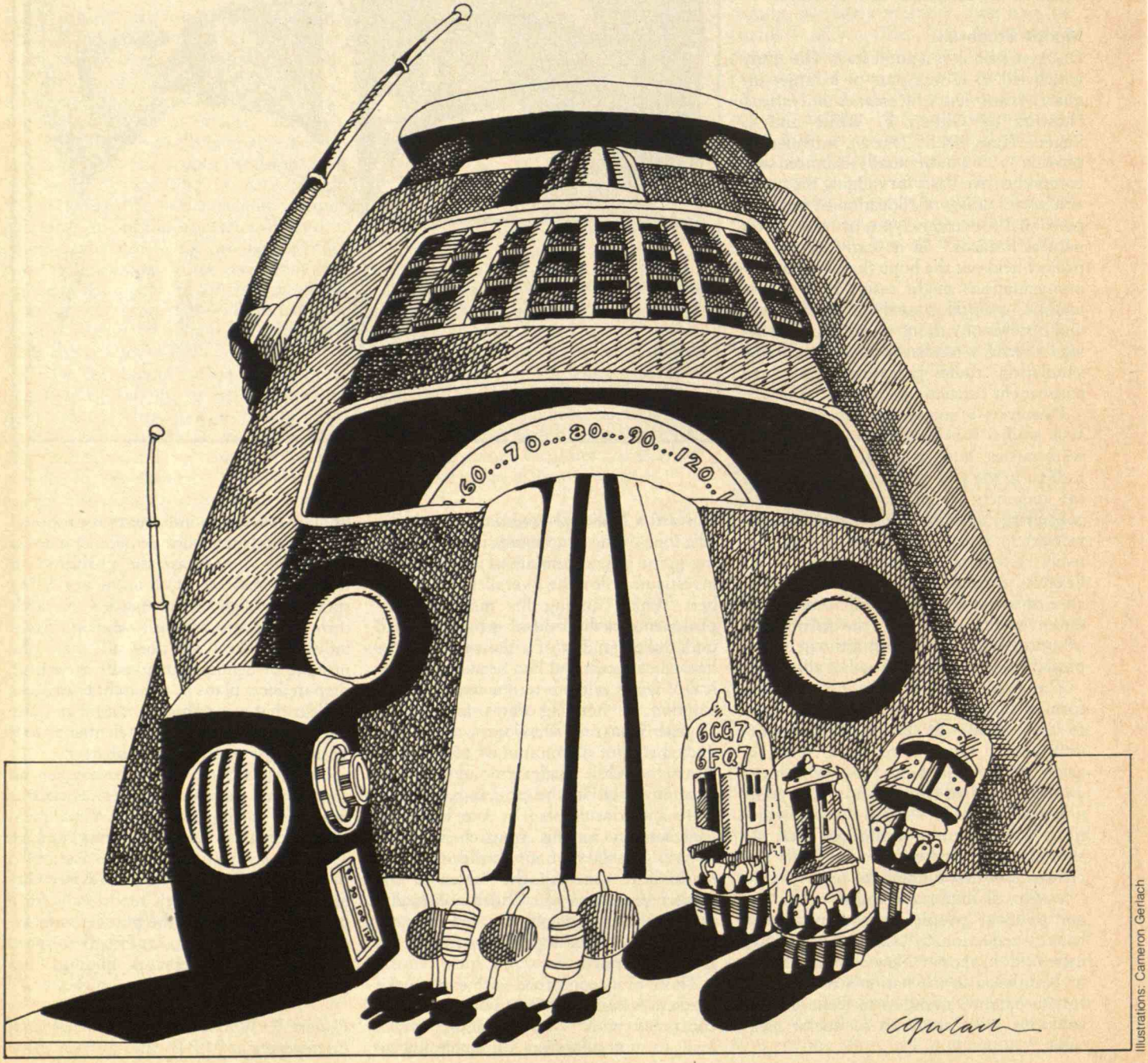

Illustrations: Cameron Gerlach

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Management Criteria for Effective Innovation

George R. White
Vice President
Xerox Corp.

Early in the corporate era it may have been easy to believe that technological stability was the normal condition and technological innovation the occasional, fortuitous balm for problems to which we otherwise could have adapted. But since World War II innovation has been the norm; technology-based innovations, coming in rapid sequence, have been seen as the crucial source of prosperity, the panacea for all business problems.

Now we know that this panacea is not necessarily benign. The U.S. electronics industry was in far better condition in the early 1950s, before the emergence of the transistor, than it is now with the consumer business largely penetrated by Japan. On the other hand, it is also true that a previous modest participant in electronics, the Motorola Corp., used the transistor to expand its position in consumer electronics and then, by integration backwards, gained a significant new role as a component supplier.

When compared to those available in finance, marketing, and production, the tools available to management for assessing and directing technological innovation are rudimentary. Intrigued by this fact, Margaret B. W. Graham and I determined to study in detail two fully completed, well documented innovations — the transistor in consumer electronics and the jet engine in subsonic jet transports. We postulated that the criteria for success in these cases could be applied to predicting the future outcomes in two immature innovations — the supersonic transport and computerized automobiles.

We conclude that we can in fact identify management criteria which effectively discriminate between profitable and unprofitable new technologies, and that these criteria have utility in appraising technological innovation in a wide variety of cases.

I. The Determinants of Success

We began by predicting that determinants of success could be found in both technology and business contexts. In the realm of technology, the determinants would surely depend on some appraisal of the quality and significance of the innovative concept itself: it must be new, and it must also be good. But such an innovative concept alone does not assure technical potency; there must be an embodiment for the new device, a product or system which is waiting for it. The embodiment surrounding an inventive concept has a major effect on how profitable the new technology proves to be.

Even with technical potency, a high rate of adoption and great profitability are not assured. The operational consequences of the new technology on manufacturing, marketing, and distribution must be considered.

Finally, market dynamics are extremely important — and often complex. Many industries have several dependent stages of intermediate demand; for example, transistor manufacturers sell to radio manufacturers, and radio manufacturers in turn sell to consumers. It is not enough to study the transistor market; analysis of final consumer demand is essential to understanding the outcome of transistor technology.

Balancing Old and New Constraints

Three questions turn out to be crucial in determining the technical potential of any inventive concept:

What fundamental technical constraints limiting the prior art are lifted? This is the key technical challenge: identify the core physical constraints underlying the previous technologies that have been lifted by the new invention, and assess the significance of lifting those constraints. Consider an example from the field of aircraft engines. In the piston engine, the upper limit in compression ratio is set by the detonation of the fuel charge in the cylinder. A turbine engine has no such limit; it is possible to have a higher compression ratio in a turbine engine than in a piston engine, and today's successful turbine engines do have those higher compression ratios.

What new technical constraints are inherent in the new

art? The first question had to do with the credit side, and this question determines the debit side — that is, what fundamental constraints limit the effectiveness of the innovation. In jet engines, for example, the wake efficiency or the Froude efficiency of an aircraft propulsion system depends on the ratio of the velocity of the rearward stream of air to the forward velocity of the aircraft; the lower that ratio, the more efficient the propulsion. A propeller, moving a large amount of cold air slowly, has a higher wake efficiency than a jet engine moving a small amount of hot air rapidly, so a new constraint exists.

How favorable is relief of the former weighed against the stringencies of the latter? The net of the first two questions with respect to any inventive concept is a qualitative technical balance. The comparisons cannot be quantitative because they are not necessarily of similar characteristics; so this is highly judgemental balance, but it can be technically quite meaningful.

Putting Innovations in Context

The second stage of applying these management criteria is to analyze the embodiment in which the new technology will go to market. Here again the analysis takes the form of answering three questions:

Is the end product enhanced by additional technology and components required to make use of the innovation? This question calls for an analysis of the changes which must be made to a product if the innovation is to be used in it. A good example occurs in radios. Every radio must have a power supply, an R-F section, an I-F section, and an audio section. The transistor penetrated the automobile radio as a replacement for the output power tube, but the R-F and I-F sections of the radio were unaffected by the presence of a germanium power transistor instead of an output power pentode; however, because the output stage no longer required 300-volt B^+ plate potential, it was possible to eliminate the unreliable vibrator power supplies as soon as R-F and I-F tubes requiring only 12-volt B^+ potential were developed. These hybrid radios were much more reliable, but they could not have succeeded without the 12-volt tube development.

Is the inventive concept itself diluted or enhanced by the embodiment required? Now analyze the effect on the innovation itself of the changes required for its use in the product. There are favorable cases where the additional art surrounding the new invention enhances its value; that is a very happy situation. But there are many cases where the embodiment surrounding the new art dilutes it.

Does the additional embodiment offer opportunity for further inventive enhancement? Once more a balance is needed, this time between the value added to a product and that subtracted from it by the requirements of the innovation. Does it add more punch, or does the new innovation on balance decrease the acceptability of the product into which it is incorporated?

A Balance Sheet on Financing Business Operations

The answers to these two sets of questions establish the technical potency of a new innovation, but they offer no criteria in the business context from which to judge such things as profit potential. Three questions are also involved here:

What previously-emplaced business operations are displaced or weakened by the new innovation? Assess the potential changes in existing business that will be brought about by the innovation. In the case of the entry of the transistor into electronics, the impact on the dealer service network is a perfect example. All tube sets were guaranteed to have tube failures and to require tube replacement. That phenomenon simply does not exist in transistor devices, and the dealer service network predictably declined in importance as transistors were introduced.

What new business operations are needed or wisely provided to support the new innovation? Assess the nature and cost of new business operations required by adoption of the new technology. The Japanese penetration of the U.S. consumer electronics market provides an example; it was simultaneously an innovation in distribution and retail marketing. Trading companies were now the distributors, and retail sales by stores, department stores, and discount houses replaced the previous pattern of selling which focused on the brand-franchise dealer.

How favorable is cessation of the former practices weighed against provision of the latter? Draw the trial balance again; we claim that this analysis can yield a qualitative business balance stemming from the new invention.

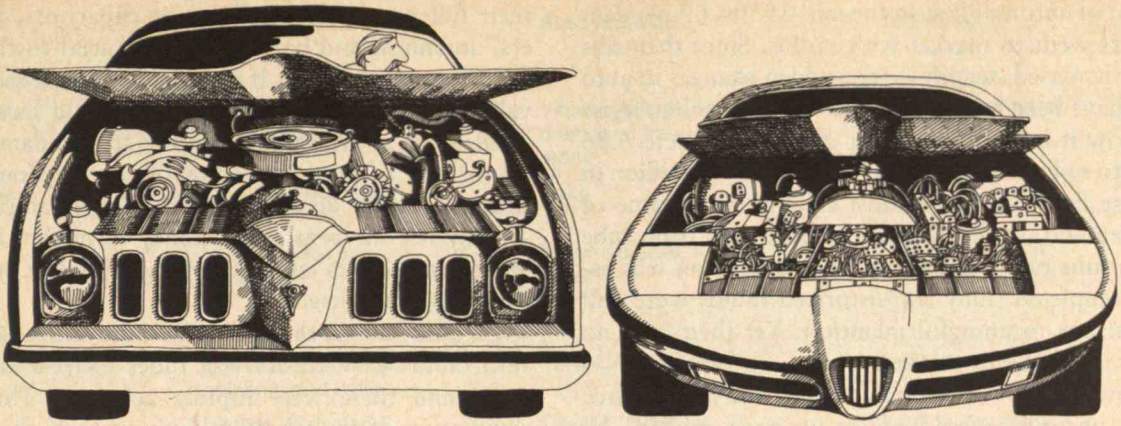
What Will Sell and What Won't

Finally, we determine a set of criteria having to do with market dynamics, on the basis of three questions:

Does the product incorporating the new technology provide enhanced effectiveness in the marketplace serving the final user? The Pilkington Float Glass Process represents a substantially more effective way of making plate glass by casting the glass against molten tin instead of grinding the surfaces; there are dramatic cost savings. But smooth glass is smooth glass, and there is no increased effectiveness resulting from its use in windows. The Process is a perfect example of an innovation which made no change at all in the marketplace; it does not, unlike many others, yield economic payback because of market expansion due to enhanced effectiveness.

Does the operation reduce the cost of delivering the product or service? Taken together, this question and the one above are really the scissors of supply and demand, the first dealing with demand, the second with supply. If the answer to both of these questions is "no," we can forget the whole thing; and if it is "yes," then there need be little market uncertainty. The challenging case is where one of these is positive and the second is not.

Does latent demand expansion or price elasticity expansion determine the characteristics of the new markets? When the factor driving a market area is lower price per unit, market expansion by hundreds of per cent is hard to obtain; major expansion in revenue is much more likely when the change in the market is driven by a dramatic change in product effectiveness. This final ques-



tion, of course, determines the quantitative business balance.

In these criteria we have avoided terms such as "return on investment" and "return on assets managed." Our view is that these issues are overwhelmed whenever a new inventive concept can be placed in a beneficial embodiment which will enhance its value in a major latent market with lowered operational costs. If evaluations of an innovation must be based on assumptions of narrow differences in return on investment, they are quite possibly based on fallacy. What we propose is a logic structure to identify a small class of innovations of great promise whose success will transcend the cash value of any normal investment.

II. Putting the Determinants to the Test of History

Some examples from our work show how this logic structure might have served as a meaningful discriminant between successful and unsuccessful innovations in the past.

The Japanese Portable-Radio Game

Consider first three aspects of the changes in the consumer electronics market wrought by the transistor. Transistor radios made their first strong showing in the U.S. portable radio market in 1956; prior to that time all portables had been tube sets. In 1956 the center of gravity of the U.S. market (according to listings in *Consumer Reports*) was in personal-size transistorized portable radios weighing an average of 20 ounces and costing an average of $57; eight models were available. This was a substantial innovation; the dominant radio in the previous year's market had been a tube-based portable weighing about six pounds. No Japanese sets were in the U.S. market in 1956.

By 1959 the U.S. industry had responded fully to the transistor as it was then applied; there were 25 portable models in the 20-ounce size, and prices were down slightly.

But in 1959 there was also a new market never populated before, filled by 11 different Japanese miniature portable sets weighing about ten ounces (less than half as much as the smallest U.S. radios then available) and costing 10 per cent less than the 20-ounce U.S. radios. The Japanese had made a dramatic innovation in the size and weight of personal portable radios and thus had opened up a new market not serviced by the U.S. industry.

The Japanese did not do this by innovating in transistors; they did it by other innovations through which they reduced the sizes of tuning capacitors, loudspeakers, battery supplies, and antennas. It was the transistor innovation supported by these additional innovations that allowed the Japanese to open up this exclusive new pocket-radio market and begin their successful penetration into U.S. consumer electronics. In fact, the U.S. industry's innovation based on the transistor was an incomplete innovation; it had not taken advantage of the embodiment surrounding the transistor as the Japanese had done.

By 1962 the market outcomes were clear. In 1955 the U.S. market for portables was 2 million sets, all tubes, and all made in the U.S. By 1962 the Japanese had captured 58 per cent of the market, and they had in fact captured 68 per cent of the market growth made possible by the transistor.

Auto Radios and TV: Who Needs Transistors?

Compare this history with that of the second transistor innovation, which was in auto radios.

In 1955 the only auto radios were tube sets; they used high-voltage R-F, I-F, and output tubes, and of course they required vibrator power supplies.

In 1956 came a new type of auto radio with no vibrator power supply, no step-up transformer, and no high B+ potential. Germanium output transistors allowed low power drain; they were driven directly by the negative-ground 12-volt power supply of the automobile battery. In addition, an embodiment innovation provided 12-volt B+ tubes to handle R-F and I-F.

Only one year later the first all-transistor auto radio, completely transistorized in R-F and I-F and with low-drain output transistors, all running directly on the battery supply, became available.

On average the tube sets of 1955 cost $45, the hybrid sets cost $8 more (a modest step-up), and the completely transistorized sets of 1957 cost $125, a luxury prestige item in the Cadillac Eldorado but otherwise priced out of

the market.

The production of auto radios follows very closely the production of automobiles. In the mid-1950s, 67 per cent of new cars went to market with radios. Since then this figure has increased steadily — no sudden changes in auto radio use have been associated with the new technologies — until now it is almost 100 per cent. There were 6.86 million auto radios made in 1955 and only 6.43 million in 1960; these figures reflect almost exactly the volume of new-car demand. In this period the transition from tube sets to the tube-plus-output-transistor hybrid set was essentially completed (fully transistorized radios were still not sold in any meaningful quantity). Yet there was no expansion at all in this market.

Turn now to color television consoles, the last of three transistor substitution innovations we have studied. All consoles marketed from 1955 through 1967 used tubes. The first transistorized console was available in 1968, but only in 1974 (almost two decades after the first transistor portable was sold) did transistorized color sets become the industry standard. Since portability and maintenance cost are dominated by the vacuum cathode-ray tube, transistor penetration was very slow.

Summing a Transistorized Balance

Portable radios, automobile radios, and color television consoles represent three different transistor innovations which were technically very similar in circuit design and in cost. Yet the business outcomes were dramatically different. Our criteria applied to this field reveal the differences in technology and its business context that led to these strikingly different outcomes.

Recall that our criteria reflected first a balancing of constraints removed against new constraints added by an innovation. In the case of portable radios, transistors meant that weight, size, and frequency of repair were all improved dramatically. For auto radios, the vibrator failure mode (which provided 60 to 80 per cent of the maintenance engagement) was eliminated and with it the problem of battery drain when the radio was used without the engine running. Frequency of repair was generally reduced. In television, transistors served only to reduce the frequency of repair. As we progress from auto radios to television, the value of constraints lifted by the transistor declines.

New technology always has new problems. The audio fidelity of the little portable radios was poor, and that is a fundamental constraint. Similarly, the capture value of the tiny ferrite antennas was not as good as that of the bigger antennas. There were no particular penalties in auto radios or in television.

Drawing a technical balance on the value of these inventions, we conclude that the portable radios presented a vast increase in portability — from six to eight pounds down to shirt-pocket-size. The auto radios offered a major increase in reliability. Transistorized television sets only had a slight increase in reliability going for them. We conclude that the portable radio had dramatic new value, the auto radio had substantial new value in its hybrid mode, and the television set had very little new value.

Next, what additional technology was required in the embodiments in which transistors were placed to realize their full potential? Small tuning capacitors, loudspeakers, antennas, and batteries were crucial to the reduced size of portable radios. If these had not been included, the value of the transistor innovation would have been diluted, since in fact tubes were not the fundamental limit on the size of portable radios. As the Japanese demonstrated — to the detriment of their American competitors — only if you spent extra money to miniaturize all the other components could you fully capitalize on the transistor invention itself.

On auto radios, the additional innovation required for auto radios were the 12-volt tubes for R-F and I-F sections, and these were rapidly achieved. This allowed elimination of the vibrator; without that, the transistor innovation would have been diluted and transistorized auto radios might not have been successful.

An interesting situation prevails in television. As far as we can imagine now, a television set requires a cathode-type picture tube. Even after 20 years of looking, we find the prospects dim for a cheap, all-solid-state display. Therefore, we are nailed to the low reliability, high repair cost, and large size of present picture tubes. There is essentially no opportunity for incremental enhancement in the embodiment surrounding the transistors.

As we compare these different applications of the transistor on the basis of these criteria statements, we can understand why the portable radio transition was complete and rapid, why the auto radio transition was quite rapid for one portion (hybrid) and quite slow for the other portion (fully transistorized), and why the color television transition was quite slow.

On the operational side, the transistor led to some business innovations. In Japan, a wholly new concept of low-cost mass marketing followed the design of nine-ounce-radios.

The fundamental change in a key component of auto radios — the output tube became a germanium output transistor — was adopted throughout the industry and led to a new business opportunity. The Motorola Co., a radio manufacturer which never made tubes in its life, was effectively able to integrate backwards and started making germanium power output transistors — first for use in its own production of auto radios and also in its military equipment and later as components for sale to others. Thus this change in technology allowed Motorola to expand its role and penetration in the industry. The transistorized television set, having only slight advantages, offered no new business opportunities; essentially it is a null case.

The application of transistors to the portable radio definitely increased the effectiveness of the product to the final user; it now became a go-with-you-anywhere radio rather than a carry-it-and-set-it-down radio. The combination of the transistor and the further innovation surrounding it led to a new product that claimed a new latent market never populated before, rather than a substitution market. In contrast, the enhanced effectiveness of the transistorized auto radio to the final user was quite slight

	Effects of the advent of the transistor on:		
	Portable radios	**Auto radios**	**Television**
Inventive concept:			
Constraints lifted	Weight, size, and frequency of repair	Vibrator failure, battery drain, and frequency of repair	Frequency of repair
New constraints	Low sensitivity, low fidelity	None	None
Advantage	Vast increase in portability	Major increase in reliability	Slight increase in reliability
Embodiment merit:			
Additional components	Condenser, speaker, antenna, and battery	12-volt R-F/I-F tubes	Cathode ray tube
Dilution or enhancement	Dilution of size and weight gains	Dilution if vibrator required	Dilution, since no rewards of small size or low weight
Additional opportunity	Enhancement if above are miniaturized	Enhancement if 12-volt tubes eliminate vibrator	No enhancement; elimination of CRT tube seems impossible
Operational practice:			
Displaced business operations	Dealer service no longer very important	Service less important	Service slightly easier
New business operations	Low transport and inventory cost encourage wide distribution network	New field of transistor and electronic manufacture opened	None
Advantage	Low-cost mass marketing opens new market to imports	Radiomakers integrate backward to transistors, auto makers to radios	Slight if any
Market dynamics:			
Enhanced effectiveness to final user	Great increase only in portability	Slight	None
Reduced cost	Higher cost in early years	Only slightly higher cost, due to vibrator savings	Much higher cost in early years
Expansion or substitution market	Expansion in miniature size only	Substitution	Substitution

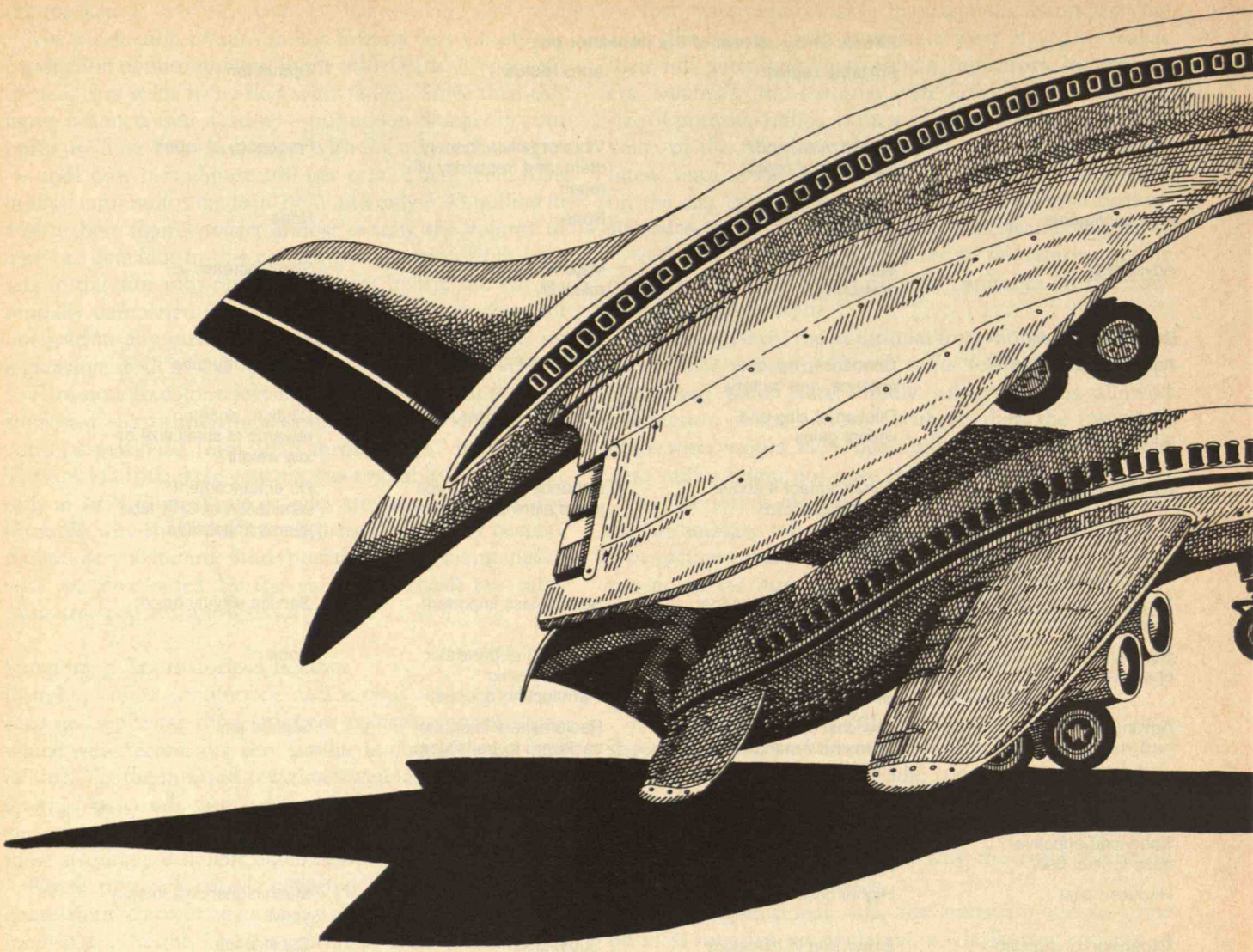
Assessing the impact of the transistor on consumer electronics. The author proposes that analysis of these 12 aspects of the changes wrought by the transistor demonstrate why its penetration was so instant and its revolution so complete in the portable radio industry, its penetration equally complete but its revolution insignificant in auto radios, and its penetration small and slow in the television industry.

— a little bit of reliability, a little bit of battery drain. It was a substitution market; in fact, the total demand did not increase at all. There simply was one radio (approximately) for every new car sold. The television case is our null case; nothing happened.

The Battle of the Turbines

Here is a brief review of how our criteria illuminate the different outcomes in the case of turbine aircraft. Here we are dealing with three fundamentally different types of aircraft — the wide-bodied jets (707 and DC-8), the Lockheed Electra, and the Boeing 727. The first jets, as well as the first Electras, entered service in 1958. By 1961 the Big Five U.S. airlines (these firms provided 75 per cent of U.S. passenger miles in the late 1950s, and they were historically the airlines which first bought new equipment) had 177 big jets; by 1969 they were using 500 such aircraft. The Lockheed Electra went from an initial 1961 fleet of 72 down to only 28 aircraft in 1969. The 727, which was not even in the first round of purchases, turned out to be the single most effective jet aircraft; by 1969 400 of them were in service in the United States.

The inventions on which these aircraft were based were largely similar — the substitution of rotating compressors and high-temperature gas turbines for reciprocating pistons. But these aircraft are very different in their ensemble of other elements beyond turbine engines — embodiment merit, according to the terminology of this article. To achieve the full potential for higher speed inherent in the turbine, the 707 and DC-8 used swept wings, at 35° and 30°, respectively. This was possible because Boeing and Douglas engineers solved (each in slightly different fashion) the problem of controlling a phenomenon called Dutch roll, which affected stability. The outcome was



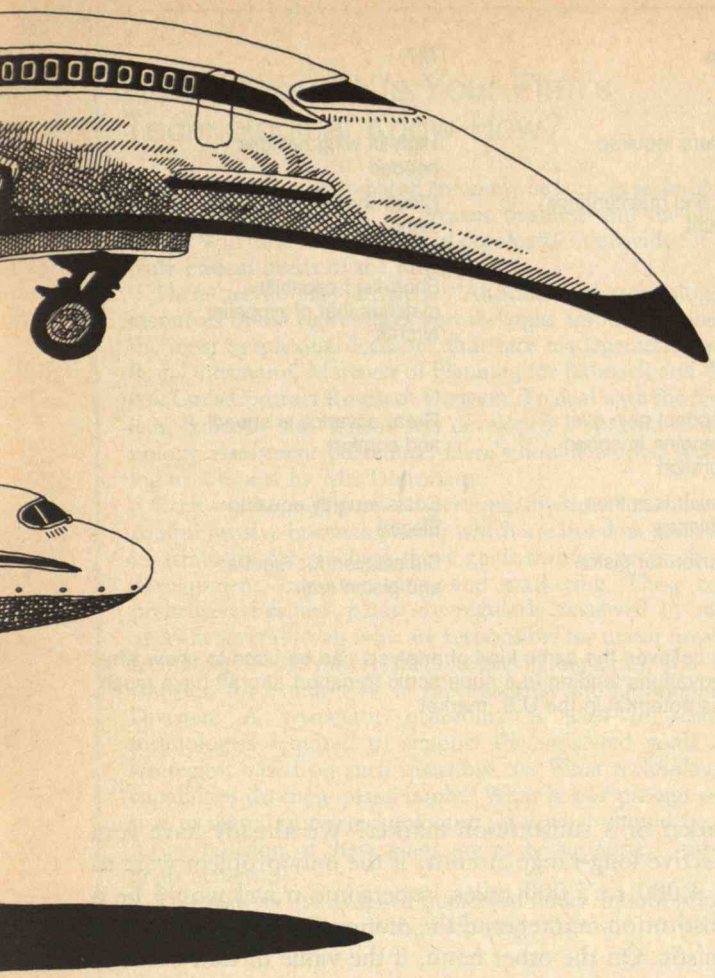
that the 707 and DC-8 were fundamentally faster than the British Comet, which was designed with a 20° wing sweep to avoid the stability problem. Thus the opportunity came not in jet engines but in solving aerodynamic problems brought into relevance by jets.

Lockheed engineers were trapped with a dilemma in designing the Electra. They concluded that they were better off moving a large mass of cold air slowly than a small mass of hot air rapidly, because of the runway length requirements of the latter. So they stuck with propellers. But propellers in fact have an ultimate speed limit, since their tips cannot easily go faster than the speed of sound, and this in turn constrains the aircraft to a top speed nearly 200 miles slower than that of a turbojet such as the 707. The Electra designers chose the old, familiar art of propellers, where no risk was entailed but no new enhancement was possible.

The 727, the third member of our jet set, has been successful because of two additional embodiment innovations — fanjet engines and high-wing-lift devices. In order to use the short runways of intermediate-range airports, the 727 had to obtain much more take-off thrust and much more lift from the wing in landing than had been possible before; yet it also required a small wing for cruising at high speed. This was achieved by using fanject engines (with cold air flow around the hot turbine exhaust) in the rear of the aircraft so that the wing was clean, and by using triple-slotted flaps with leading edge slats which provided the equivalent of a variable-configuration wing. The innovation was effective; the 727 ended up with short-field capability that matches that of propeller aircraft, yet it cruises at speeds typical of all jets.

Market dynamics are the next criteria of importance. The 707 and DC-8 presented a great advantage in comfort and speed; they flew higher and faster than any aircraft before, and it was simply more pleasant to travel. In addition, because of their high speed and capacity, they cost less per seat mile to operate than long-range piston planes. So the best of all possible worlds obtained: demand was higher and cost was lower. These aircraft led to a strong market expansion for air travel.

The Electra offered only modest improvements. Some of the vibration coming from piston engines had disappeared, but Electras could not fly as high or as fast as the jets. Operating cost per seat mile excluding depreciation was less than that of medium-range piston aircraft, but this meant a market based on substitution (slowly penetrating by doing the same function against depreciated



equipment), not one based on expansion (rapidly penetrating on the basis of payback from new customers).

Finally, the 727 had the speed and comfort of the big jets and costs roughly equal to the Electra, and it could fly in and out of the smaller airports. As soon as the 727 was available all of the intermediate-range traffic, piston or Electra, went to it.

III. Forecasting Future Innovation

Now that we have seen how the innovation criteria apply to the transistor case and to the case of jet aircraft, it is appropriate to make some general statements about their application to two prospective innovations, microprocessors for automobiles and supersonic transport aircraft.

Automotive Microprocessors: Everything Up

Microprocessors promise flexibility and precision of control and operation of automotive engines that are simply not available in mechanical control systems, and this is the heart of the technical advantage.

At the level of embodiment, we find that the sensors and actuators, not the computer chips, are the most crucial components requiring further development. An automobile is an analog mechanical environment; a microprocessor is a digital electronic environment. We need either sensors, actuators, and/or analog-to-digital converters, and these are the key embodiment elements. We also know that they represent the dominant portions of system cost and are the dominant determinants of system performance. If these can be made right, there will be regulatory benefits, better driveability (which to the auto industry means desire to buy cars), and long-life, stable performance; automobiles will stay in tune and their control and performance functions will not deteriorate over the life of the car.

These will be major new design, manufacturing, and marketing opportunities, and our operational practice criteria are useful in seeing how to make a business operation out of these possibilities. Absolutely, one would expect that firms such as Bendix or TRW (with aerospace and electronic skills and a large presence in the auto industry) could take advantage of this opportunity to expand backwards (as Motorola did with auto radios) into special electronic precision sensors and actuators, seizing a key part of this technical ensemble for a long-term, stable market. We also have the possibility of car manufacturers expanding their domain of technical activities.

The market that is implied by these prospects for computerized automobiles is absolutely unique. It has been decreed by the U.S. government. Microprocessors and related control systems do not have to be evaluated against the cost of today's mechanical alternatives; they offer the most promising way we can yet envision to meet emission and economy standards mandated for motor vehicles in the 1980s. There is a billion-dollar value to manufacturers in avoiding the fines for high fuel consumption or the pre-emption of marketability if new automobiles fail to meet pollution standards set by federal law. The value to the auto industry hinges not on new revenue gain — because all the industry can hope to do is continue to sell high-value cars — but rather on the avoidance of loss.

The Fundamental Problem of the S.S.T.

To evaluate prospects for a supersonic transport, one can go through the same four-point check sequence on criteria. The key inventive concept, the thing that is fundamentally new on supersonic transports, is supersonic aerodynamics, the increase of aerodynamic drag at supersonic speed. Two different aerodynamic structures to deal with this problem have been examined in the U.S. One (which is now a failed concept for transports) is the swing wing; the other, which survived until the entire transport project was shelved, is a wing swept back at an angle sharper than the Mach cone so the wing is subsonic while the airplane is supersonic.

This is a good concept. But it cannot deal with the fact that aircraft flying faster than the speed of sound always leave a sonic boom below, and the energy required to overcome that lost in the sonic boom results in high fuel consumption. So there is a good concept, but it has some debits.

Now we go to the embodiment criteria. The key regulatory decision was that sonic booms would not be

	707/DC-8	Electra	727
Embodiment merit:			
Additional components	Swept wings required	Propellers required	High-lift wing devices needed
Dilution or enhancement	Slight roll control problem	Speed and maintenance constraint	Clean wing with triple-slotted flaps from rear engine
Additional opportunity	Speed advance over Comet due to high sweep angle	None	Short-field capability matches that of propeller aircraft
Market dynamics:			
Final user effectiveness	Great advance in speed and comfort	Only modest gain over piston engine in speed and vibration	Great advance in speed and comfort
Cost reduction	Net cost less than long-range piston	Cost much less than piston planes	Costs roughly equal to Electra
Expansion or substitution market	Strong expansion	Substitution for piston craft	Substitution for Electra and piston craft

The battle of the turbine-powered transports. Only six of the author's 12 criteria are needed to demonstrate the superiority of pure jets in the marketplace — why the 707, DC-8, and 727-type aircraft became the standard for U.S. air travel in the 1970s. He believes the same kind of analysis can be used to show why innovations leading to a supersonic transport aircraft have much less potential in the U.S. market.

allowed over the U.S. So American supersonic aircraft must be efficient at subsonic cruise over the U.S. as well as at supersonic cruise over areas where boom is permitted. This requires what are called variable configuration engines, operating in by-pass mode below the speed of sound and as straight jets above — a corollary innovation. The sharply swept wings present some unique control and stability problems; they lack the inherent stability of conventional wings, behaving much like classroom paper airplanes. There must be active controls, called "fly-by-wire." This is not hard; but creating reliable "fly-by-wire" equipment that will last for the 20-year life of an airplane presents a significant challenge.

A supersonic aircraft requires structures that go beyond those we have had before, because supersonic flight causes thermal as well as aerodynamic loads. The required composite materials represent a new art which now must be mastered.

Finally, we have a question about pollution: we absolutely know that oxides of nitrogen behave differently in the meteorological system at 65,000 feet than at 25,000 feet. The problem is that we do not know how they behave. If these oxides lead to depletion of the ozone layer, we will have somehow to change engine combustion.

If we understand all these embodiments surrounding the supersonic wing innovations, we can proceed to the issues of operational practice. The key problem here is that the U.S. domestic market has underwritten the basic costs of all major air transport innovations since the DC-3. It will not do so for the supersonic transport; long-range aircraft earn value only in international travel. Our airlines and our manufacturers need to understand what it means to be primarily international; pooling of traffic and manufacturing consortia are probable.

The market outcome is not clear. Is it an expansion market or a substitution market? We already have very effective long-range aircraft; if the only problem were to fly 4,000 to 5,000 miles, supersonic travel would be a substitution market, and the economics would not be optimistic. On the other hand, if the value of time saved is substantial, it is conceivable that supersonic travel could result in a market expansion.

Having followed this procedure of drawing orderly balances in the areas of inventive concepts, embodiment merit, operational practices, and market outcomes, I have concluded that, though no single constraint prohibits supersonic transports from being commercially successful, the broad array of concerns says that the mere passage of time will not assure an S.S.T. There must be some urgent national mission to override some of the constraints to their emergence.

We believe our procedure for evaluating the viability and likely outcomes of an innovation can largely account for the differentiated outcomes in high-technology businesses — businesses that are as far removed from each other as transistor radios and jet transports. When these criteria are applied to important potential future innovations, they indicate plausibility for a computerized car, given a reasonable regulatory atmosphere, and they indicate implausibility for many years for a U.S. supersonic transport. We are convinced that a similar analysis can be useful in indicating the likely future course of other projected innovations.

The research reported in this article was done by **George R. White** during 1976-77, when he was Carroll — Ford Foundation Visiting Professor at the Harvard Business School, on leave from his assignments as Corporate Vice President and Vice President — Information Technology Group of Xerox Corp. Dr. White studied physics at Wesleyan University (B.A. 1950) and Iowa State University (Ph.D. 1955), and he holds a Master's degree in business administration (1967) from the University of California (Los Angeles).

How Adequate Is Your Firm's Technological Know-How?

How can a technology-based company be sure its technology is adequate to support its present business and its future plans? Will today's research and development provide for the truly critical needs of the future?

There are no easy answers. "Allocation of technological resources in the right places and the right amounts is one of the most perplexing decisions that face management," says R. J. Dohrmann, Manager of Planning for Babcock and Wilcox Co.'s Contract Research Division. To deal with the problem, Babcock and Wilcox has developed a systematic technology assessment procedure. Here's how it works, according to a report by Mr. Dohrmann:

Each of the Company's operating divisions maintains a comprehensive business plan in which are listed its goals and its strategies for reaching those goals through research and development, manufacturing, and marketing. These comprehensive business plans are regularly reviewed by managers at several levels who are responsible for major areas of technology — chemistry, metallurgy, mathematics, and heat transfer, for example — in the Research and Development Division. A systematic procedure is used to identify technologies required to support the indicated goals and strategies, based on such questions as: What technological capabilties do these plans imply? What is our present position in these critical technologies? And what should be our future position, if these plans are to be supported and the goals achieved?

The answers are assigned numerical ranks in both present and future, according to the following table:

Rank	Position	Present status	Future need
3	Leadership	High technical proficiency; ahead of competition	Leadership in product quality and market acceptance through technology
2	Strongly based	Good technical foundation, broad base	Parity in product quality and market acceptance through technology
1	Knowledgeable	Adequate depth and familiarity	Maintain technology that has secondary impact on product quality and market acceptance
0	No knowledge	Insufficient technical support	

From these numerical ratings, it's easy to reach for each critical technology what Babcock and Wilcox calls a Technology Adequacy Rating (T.A.R.):

$$\text{T.A.R.} = \frac{\text{Where we are}}{\text{Where we need to be}}.$$

The points of danger stand out clearly — any T.A.R. under 1.0 — and priorities can be assigned on the basis of how soon the need will be felt and how critical it is in relation to overall corporate plans. Combined across product lines, the results are tabulated on a master Technology Assessment Form (*below*) from which the Research and Development Division can easily read its marching orders. — *J.M.*

Line Item	TECHNOLOGY	Where We Need To Be Ranking A	Where We Are Ranking B	Technology Adequacy Rating B/A	WHEN REQ'D., YEAR	PRIORITY	PRODUCT LINES													
							PRODUCT LINE "A"					PROD.L."B"			PRODUCT LINE "C"					
							Product A_1	Product A_2	Product A_3	Product A_4	Product A_5	Product B_1	Product B_2	Product B_3	Product C_1	Product C_2	Product C_3	Product C_4	Product C_5	Product C_6
	TECHNICAL SECTION "A"																			
1	- Technology a	2.5	1.5	.60	76	2	X													
2	- Technology b	2.0	2.0	1.00	76		X													
3	- Technology c	2.0	1.0	.50	77	3	X													
4	- Technology d	2.0	2.0	1.00	77		X													
	TECHNICAL SECTION "B"																			
5	- Technology e	2.5	2.5	1.00	76		X	X	X	X	X	X	X	X	X	X	X	X	X	X
6	- Technology f	2.0	2.0	1.00	78		X		X	X			X			X	X	X		
7	- Technology g	2.0	1.5	.75	76	1	X				X						X			
8	- Technology h	3.0	3.0	1.00	76		X	X		X		X		X	X		X	X		X
9	- Technology i	2.0	1.0	.50	77	1	X													
	TECHNICAL SECTION "C"																			
10	- Technology j	1.0	1.0	1.00	78		X		X			X	X	X				X		
11	- Technology k	2.0	2.0	1.00	76		X													
12	- Technology l	1.5	1.0	.66	76	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X
13	- Technology m	1.5	.5	.33	79	3	X	X				X		X	X	X	X			X
14	- Technology n	3.0	3.0	1.00	78		X		X				X					X	X	

	Rating
Leadership -	3
Strongly Based -	2
Knowledgeable -	1
Not Knowledgeable -	0

Innovation: The Fruit of Success

Robert N. Noyce
Chairman of the Board
INTEL Corporation

There are enormous opportunities for innovation in America. But we are now killing too many of the incentives for the geese that lay the golden eggs.

A panel of industrial managers on which I was recently a participant was asked about the ability of the U.S. to maintain a lead over the rest of the world in the highly competitive business of technological innovation. A leading German industrialist who was a member of the panel volunteered an observation: it's true that other nations are spending large amounts to subsidize research and development in new technology, he said. But in doing so Germany has "a major disadvantage." He pointed out several individuals around the room who had left major companies to start their own firms with a new idea or a new approach. "That just doesn't happen in Germany," he said. "And I doubt that we'll ever catch up." He meant it.

I am not consciously a student of innovation or its management. I have been closely involved in two highly innovative enterprises and can offer some observations, but I've made no statistical studies. When interviewed by students of innovation, I usually respond by saying, "But I was only doing what I wanted to do. Sometimes I had to change certain things so I could continue to do what I wanted to do."

The Risk of Not Meeting One's Goals

What are the sources of innovation? There's an old saying that necessity is the mother of invention. That's my answer: the motivation for innovation is the necessity for change. In the semiconductor industry, where no product has lasted more than five years, there is no chance to rest on your laurels and not go on with the battle.

People have often asked me if I felt I was taking a great risk. The answer is that I never felt there was any great risk in starting new ventures. The greater risk was missing an opportunity and therefore not meeting my own goals. I always knew I could go out and get another job, so I wouldn't starve. And the jobs I left were not so challenging to me as the new prospect.

Risk-taking is a question of confidence in the outcome. Though I had worked since I was 12 years old, my total experience in business at the time we started Fairchild was about four years. So I didn't know that failure could occur. That was a major advantage: though observations of failure may lead us to avoid obvious mistakes, they may also discourage us from innovation, which must be approached with confidence in success.

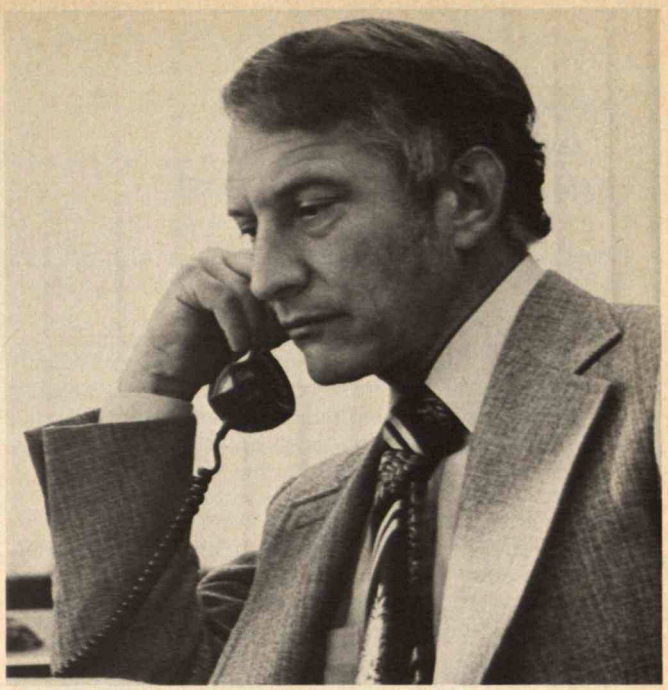
Looking at some of the motivations and some of the changes I went through in the early, formative years will, I think, be instructive. After finishing at M.I.T. in 1953 I went to work for Philco. I had offers from R.C.A., General Electric, I.B.M., and Bell Labs. When I went through those laboratories, I decided that they all knew what they were doing. But Philco needed me: I would be a necessary cog in that machine. I don't mean to run down the other organizations. It's just that I felt that in those larger, better-founded research organizations I wasn't going to have an essential role.

Then Philco did something which was, I suppose, in the end the cause of my leaving. They told me, in effect, that I could continue to work on what I was doing if I could get the government to pay for it. I decided that Philco wasn't really interested in my research; it was just another way to collect money from the government. I have since compared doing cost-plus research for an industry to putting your venture capital in a savings account. You're not going to lose much, but you're certainly not going to gain much, either.

The moral of that story is that an innovative scientist must be recognized as necessary and vital to the future of the organization. Cost-plus research communicates the opposite message.

"Am I Really Needed Here?"

I joined Bill Shockley at his new company primarily because I wanted to play in the big leagues. He clearly was the father of the industry; he shared a Nobel Prize for the invention of the transistor a year after I went to join him.



Noyce: "I never felt there was any great risk in starting new ventures. The greater risk was missing an opportunity. . ."

I recall one episode at Shockley Transistor that may be instructive in how not to motivate your people. One morning I came to talk to Bill about some new results I'd just found in the laboratory to check if my interpretation was right. And he called some friends back at Bell Labs to ask them that question. Suddenly an uncertainty came to my mind: Am I really needed here? If he can call friends at Bell Labs and gets answers to the same questions that I was trying to answer in the laboratory, my presence here isn't that important. If other people agree with what you do, then you can go ahead.

There's another story with the same moral which I haven't told very often because it seems like sour grapes. I have in my notebooks from those years a complete description of the tunnel diode. When I showed it to the boss, he showed no interest in the idea, so we went on to other projects. (Not that I missed anything; the work had been done elsewhere and was published shortly thereafter.) The message of "no interest" is certainly a demotivator.

Finally we got down to the question of whether to work on transistors or four-layer diodes. I frankly was more interested in transistors. There was an immediate market for transistors, but there seemed to be a problem in developing a market for the diode.

That was in 1957, and it was then that a group of us started what is now the Fairchild Semiconductor Division, to make transistors. Individual venture capital had not really become popular. Most of the places where we were directed to look for capital turned out to be corporate sources. Fairchild responded immediately. They said, "We've looked at that field. It's a fertile field. You've got a good approach to it. You've got adequate capability in your people." So they went ahead and funded our venture, offering what was for me at that time a phenomenally high reward: if you succeed at this, we'll pay you several years' salary all in one chunk. That deal left no question about the objective, and there was no question about what really got me interested. The criterion was earnings. There was no interest in research papers, no interest in professional pride. There was only one goal: to make the profit-and-loss statement come out right.

That organization was the start of what is now called "Silicon Valley," the beginning of all the semiconductor companies in the Santa Clara Valley — Rheem which later went to Raytheon, Signetics which later went to Phillips, General Microelectronics which later went broke, National, Intel — the source of the planar transistor, the integrated circuit, the MOS circuit, and many more.

The reward system in all of these ventures was based on success, and the motivations were extremely high. Not too long ago I was in Russia, and I found that academicians in that society are really very well rewarded. I asked them about getting their technology into Russian factories somewhere, and they said it was very difficult.

After I came back I characterized it this way: in America, when you get your new technology into a profit-and-loss statement they make you a millionaire. In Russia it's quite different: if you go out and manage a factory and you miss the quota, they make you a miner in Siberia.

A Power Struggle Between "Yes" and "No"

One advantage in start-up situations is that the technical staff is also the sales force. In the early days, the technology people have to be out talking to the customers almost on a continuous basis so they have feedback on the direction in which to go. The motivation to look very closely at the profit-and-loss statement keeps you very sensitive to market needs and costs.

As Fairchild grew we lost some of that original flexibility, so I left to try again to do it better. I can see some of the mistakes we made at Fairchild; let me mention some of those that I think are important.

Most important, I think, is the fact that, because Fair-

Economics vs. Innovation: How Whirlwind Almost Lost

Remember Whirlwind, the innovative, large, high-speed digital computer built at M.I.T. in the 1940s and 1950s which is now on exhibit at the Smithsonian?

A chief ingredient of its success was its managers' willingness to "back the man instead of the project." And the man — in this case two men, Jay W. Forrester and Robert R. Everett — in turn refused to let "economic doctrine" rule their laboratory; they were determined to do the job "on our terms or let it be shut off."

Believing that the unorthodox research and development program which spawned Whirlwind and its magnetic core memory was a subject of "legitimate contemporary concern and controversy," Professors Kent C. Redmond of Fairleigh Dickinson University and Thomas M. Smith of the University of Oklahoma have spent more than a decade studying the project and its two leaders. (Mr. Forrester went on to develop system dynamics as a member of the faculty at M.I.T.'s Sloan School of Management, and Dr. Everett is President of Mitre Corp.) The historians conclude that Whirlwind's success was a product of good technology, good timing, and good luck.

Mr. Forrester "would have nothing but the best for his project, in personnel, equipment, or supportive ... facilities," write Professors Redmond and Smith in a summary of their findings in *Spectrum (October, 1977, pp. 50-59)*. When the time came to staff the project, Mr. Forrester wrote his M.I.T. bosses, "The general type of man we need should have originality and what is often referred to as 'genius.' He should not be bound by the traditional approach."

Whirlwind began when the Navy sought a computer for analyzing aircraft stability and control; the specifications required the machine to operate so quickly that it could create "the illusion of a cockpit in actual flight." It turned out to be a formidable assignment, prescient of future military and civilian computer needs. But cost overruns in the context of post-World-War-II military research cutbacks left Whirlwind's Navy sponsors breathless and their congressional critics dismayed. The whole thing was about to be called off when the Air Force stepped in to utilize Whirlwind for managing air defense.

Gordon S. Brown, who was Messrs. Forrester's and Everett's boss as Director of the M.I.T. Servomechanisms Laboratory, was convinced that academic research and development carried on "under very liberal controls" was most productive, leaving "to each investigator all the latitude he could wish for in the conduct of his work.... It was a matter of finding a good man and turning him loose to make his own mistakes. If he made too many, replace him."

The Whirlwind project passed that test with flying colors. But one of its lessons is yet to be learned, think Professors Redmond and Smith: "In government and corporate policy circles it continues to be taken for granted that research and development policy judgments should be subordinated to economic policy judgments in the conduct of technical affairs; any view to the contrary may be dismissed as naïve and oblivious to the situation in real life." — *J.M.*

child Semiconductor was extremely profitable, the corporation drew money out of it to put into other entrepreneurial start-ups. In a sense, we were hurt by our own example of success; the parent company's management apparently concluded that if you simply support a group of people and give them some money, they will soon come back with more money than you gave them. In the case of Fairchild Semiconductors this happened after only two years, which is very short. As management drew down our resources, we gradually lost significant amounts of our total capability. At the same time, corporate management failed to give major attention to the semiconductor organization, and this made us feel no longer important.

And I have to take responsibility for some very counterproductive policies and practices, too.

One is what I call group-think. As we built up capabilities, we collected many experts in applications, finance, marketing, etc. Any decision to go along with a new product innovation had to pass through a very narrow gate. A single negative vote could kill a project, and one positive vote was worth approximately zero. I wondered if we should have done it the other way, so that a single yes vote could initiate action.

I did do that with my requisition system in the organization. When an engineer filled out a requisition, a buyer placed the order. Anyone who wanted to stop the order had to call the purchasing agent and direct him to cancel. That worked well; it was far better than waiting six weeks for the president to sign the requisition.

On the other hand, our incentive pay policy for the product managers in the factory turned out to be counterproductive. We developed a simple system of rewarding managers on the basis of the gross profit on their lines, which sounds just grand. But this reward turned out to be a very short-term motivator. It was absolutely impossible to add a new product on any manager's line. Each manager wanted to shove it off on somebody else, because each manager knew that new products lose money for at least the first three to six months; any new product that he had to launch was going to cost the manager money out of his own pocket.

I began to feel during this time that big is bad. The spirit of the small group is much better. Everyone works much harder. They cooperate more, because each can see the total impact of his or her activities.

Entrepreneurs Aren't Much Interested in Retirement

By the time I left Fairchild to try to do it again, the competition was really entrenched. At the time Fairchild started, the largest semiconductor company was less than $50 million in annual volume; by the time we started Intel, the largest company was about $500 million — and it was a powerful company that had learned how to do the business. So our new strategy was to avoid that competition by doing something new.

After looking back and examining the advantages Fairchild had, we decided to emphasize young, eager people at Intel. We wanted to find people who had the motivation and stamina to put in the long, dedicated hours

necessary to make a new company succeed.

Once more we set up very high rewards. We gave options — and we still do — to every professional employee of the company. But we have no retirement plan. We've found that — compared with more immediate rewards — there's not much interest in retirement plans among people with an entrepreneurial spirit.

The person we hired was typically going to a much smaller responsibility than he previously had, as measured by title, the number of employees we had, or the salary that we paid him. We wanted him to come with us because he was interested in the project and was willing to take a risk. I don't like the idea of hiring a salesman who wants a salary instead of a commission. I want him to be confident that he will do better on commission. We tried to get experienced people so we were at least starting even with the state-of-the-art.

We pioneered the electronic watch; as you know, the pioneer is the one with the arrow sticking out of his back. The watch business has been good, but it has also been very painful.

We had a much happier experience with the microcomputer, which Intel also pioneered; it was introduced by Intel only five years ago and is already making major changes in the way people think about the use of the computer in the future. With an 80-per-cent certainty, you'll have a microcomputer in your automobile by 1980. You'll have one attached to your television set to play games with — probably within the next couple of years. Building your own microcomputer is becoming as popular among hobbyists as building a hi-fi set was in an earlier era.

Intel is making it tougher for others to compete with us. This is a typical big-company attitude. We're taking on some longer-range projects to widen the areas of our application; I feel that you can plan as far ahead as you can look back on success. And we're doing a lot of rear-guard action to be sure that somebody doesn't come along and hurt us. We want to force new entrants into our territory to find new areas of activity and new innovations for success; we don't want them to make their success at our expense.

A Coming Crisis in Innovation

I am convinced that there are still enormous opportunities for innovation, that we still have huge changes coming in our life-style. But I also feel that we are approaching a crisis in innovation. I fear that we as a country are growing closer to the Russian reward system, as I call it, in which there is no incentive for small organizations to succeed. I remember the Germans' feeling that they'll always be a step behind because they don't have the small independent organizations to innovate.

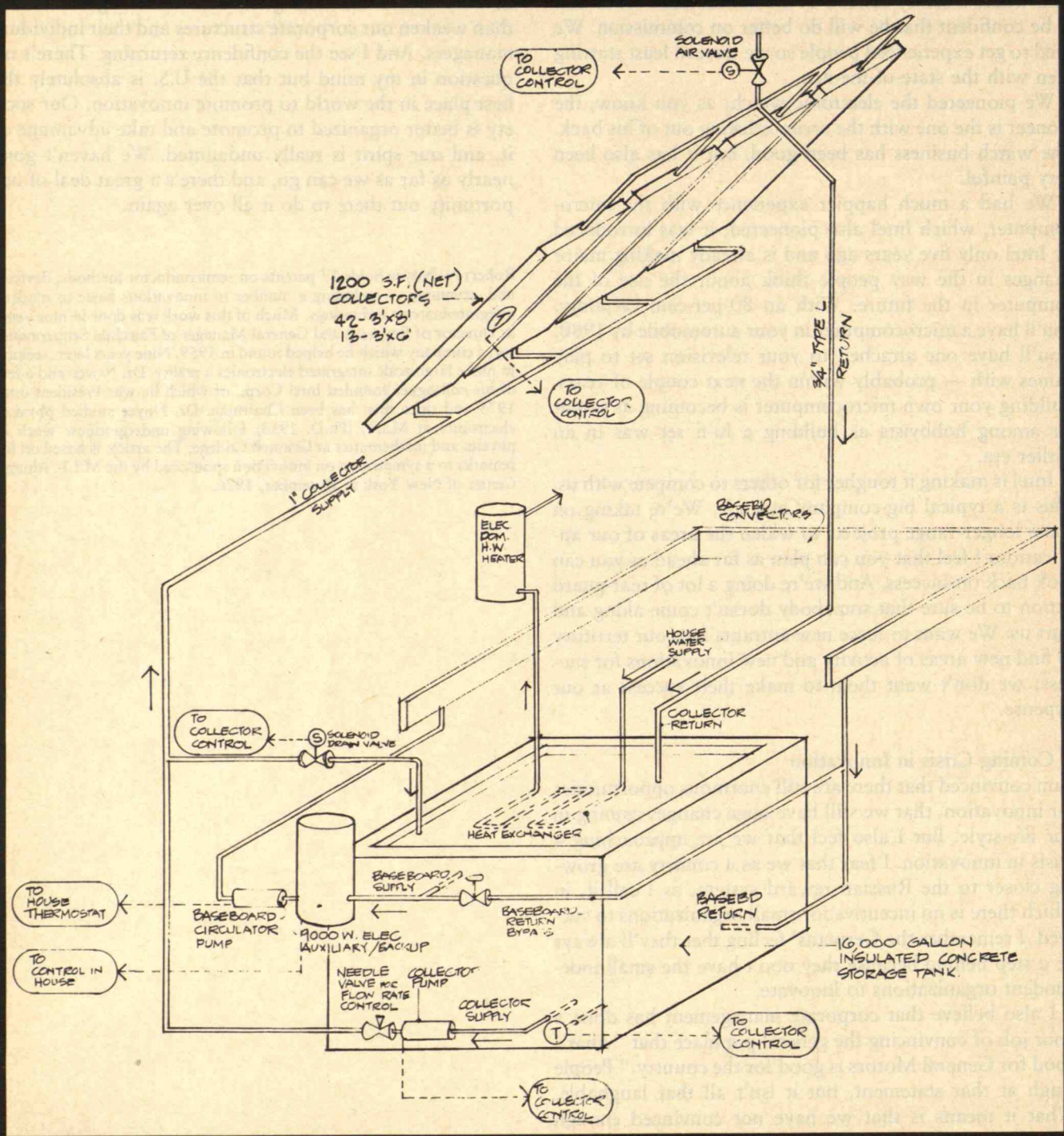
I also believe that corporate management has done a poor job of convincing the general populace that "what's good for General Motors is good for the country." People laugh at that statement, but it isn't all that laughable. What it means is that we have not convinced enough Americans that the success of its industry is in fact crucial to the success of the nation and all its people. We're not attracting our best young people to industry. We're killing the goose that lays golden eggs.

Finally, it seems to me that the overall attitude of our society is quite different from that of a decade ago; there isn't the same "can-do" attitude that we had in the 1960s. Any time we try to solve a problem we seem increasingly to turn to subsidy, thus weakening or driving out private enterprise; business can't compete with the false economics of government. I think there are enormous dangers in continuing such counterproductive actions.

Yet I'm optimistic, and I guess that's one of the basic characteristics of the entrepreneur. Our nation's downhill trend can be changed if we can really clarify our goals as a country and if we take great care to strengthen rather than weaken our corporate structures and their individual managers. And I see the confidence returning. There's no question in my mind but that the U.S. is absolutely the best place in the world to promote innovation. Our society is better organized to promote and take advantage of it, and our spirit is really undaunted. We haven't gone nearly as far as we can go, and there's a great deal of opportunity out there to do it all over again.

Robert N. Noyce holds 17 patents on semiconductor methods, devices, and structures — including a number of innovations basic to modern integrated circuit technology. Much of this work was done in nine years as Director of Research and General Manager of Fairchild Semiconductor, a company which he helped found in 1959. Nine years later, seeking to make large-scale integrated electronics a reality, Dr. Noyce and a few of his colleagues founded Intel Corp., of which he was President until 1975 and since then has been Chairman. Dr. Noyce studied physical electronics at M.I.T. (Ph.D. 1953) following undergraduate work in physics and mathematics at Grinnell College. The article is based on his remarks to a symposium on innovation sponsored by the M.I.T. Alumni Center of New York in December, 1976.

The solar heating system in the Hyman home in Waltham, Mass., uses a system of rooftop collectors, pumps, a large storage tank, and water to transfer heat. The schematic diagram reveals how the components are connected. Water, pumped through the collectors to gather solar heat as needed, is drained into the storage tank when pumping stops and air valves high in the attic open. (Drawing: Massdesign Architects and Planners Inc., Cambridge, Mass.)



Solar Economics Comes Home

Mark Hyman, Jr.
President
Solar Heat Corporation

The sun can supply most of the heat needed by a home through the long New England winter. But costs are high.

So you're thinking of going solar. Well I, too, thought about it . . . and then I did it — built my own solar home. Since July, 1976, when my wife and I moved into our home in Waltham, Mass., a suburb of Boston, we have used the sun both for space heating and for heating domestic hot water.

Why Solar?

We chose solar because the world is running out of fossil fuels. Not even the most conservative of us can deny that fact; the only possible area of real disagreement is over when the end will occur.

In theory, plenty of energy is beamed down to us from the sun to serve all our energy needs for several billion years. But the promise of gathering and using the energy in sunshine must be fulfilled in an economical way. In the past it has been economics that has prevented widespread utilization of solar energy; at present, cost is still a major obstacle. But as the cost of conventional energy rises, some solar options are becoming increasingly attractive.

One of the most likely options is the use of the thermal energy in sunshine to heat our buildings and domestic water. Anyone in the Northeast who is using electricity priced at 5 cents per kilowatt-hour (or higher) for either space heating or domestic hot water heating is a prime candidate for solar thermal systems.

Realizing that the necessity for solar heating was drawing near, I undertook the project of building a solar-heated residence. In retrospect, I consider the results successful because the project has met the three objectives I set for it:

☐ The solar space heating system should provide close to 100 per cent of our needs during an average winter in the Waltham area.

☐ The solar domestic hot water system should provide about 90 per cent of our needs.

☐ The house should fit in well with other homes in the neighborhood to demonstrate that a solar home need not have a strange appearance.

To meet the first of these objectives — designing the solar space heating system — I built a small 12-by-12-ft. solar test house in the summer of 1974. The test facility was needed because none of the 75 or so solar homes operating in the U.S. at that time was designed for total solar heating in an area of high fuel demand and because local weather information was needed. From data gathered at this facility on solar input, outdoor and indoor temperatures, and efficiency, I was able to design the heating system for our full-scale residence.

A Generous Array of Solar Collectors

Gathering enough thermal energy from sunlight to heat fully an average home such as mine, with 2,300 square feet of living space, takes a generous collection area. I use 55 individual collectors that cover the back, south-facing roof, which is at a 50° pitch to the horizontal and faces 10° west of true south. The collectors have a total effective heat-absorbing area of about 1,200 sq. ft., which satisfies the house's net space heat demand — about 500,000 B.t.u.s — on an average January day. To accommodate the shape of the roof, 42 of the panels are 8 ft. long and 3 ft. wide, and 13 are 6 ft. long and 3 ft. wide.

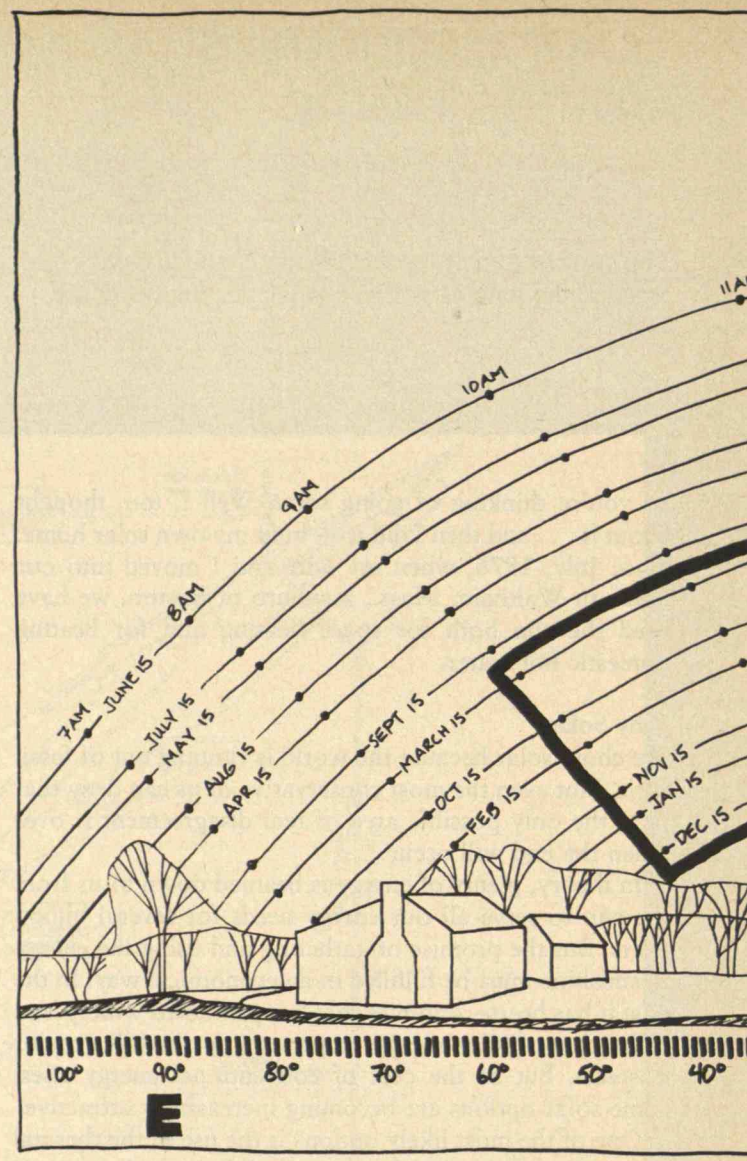
The solar collectors consist first, of a blackened metal absorber plate with which tubes carrying the heating water are in contact, behind which is insulation, and in front of which is an air space followed by transparent glazing. Sunlight enters each collector through the glazing, passes through the air space, and strikes the absorber plate, which conducts heat to the water pumped through the tubes.

The Basement Heat Store

Some solar space heating systems use water as the heat transfer fluid; others use air. I chose water because it does a good job of storing its own thermal load, and because the heated storage water can be circulated directly through the baseboard radiator system in the house. Also, a pumped hot water heating system is relatively silent. A typical solar hot air system stores heat in insulated bins of rocks — usually in a basement — through which the heated air is blown. However, rocks have only about one-half the heat storage capacity of an equal volume of water and therefore require at least twice the volume to duplicate a given amount of water storage. Also, vibrations within large air ducts and the sounds of circulating fans are often part of the price one must pay for a forced hot air heating system.

In my final design, water heated in the collectors is pumped into a 16,000 gallon basement storage pool with net inner dimensions of 24 ft. (across the basement) by 15 ft. by 6 ft. deep.

A collage of photographs, all of which were taken from a point 8 ft. above the ground and centered on the rear of the house, were traced to yield this chart, which reveals objects that could cast shadows on the roof of the Hyman house. The path of the sun throughout the year and a grid showing the altitude of the sun and the time of day were then added to the tracing. Objects inside the darkened "window" cast potentially troublesome shadows. The original of this "Skymap" was rendered by Massdesign Architects and Planners Inc.



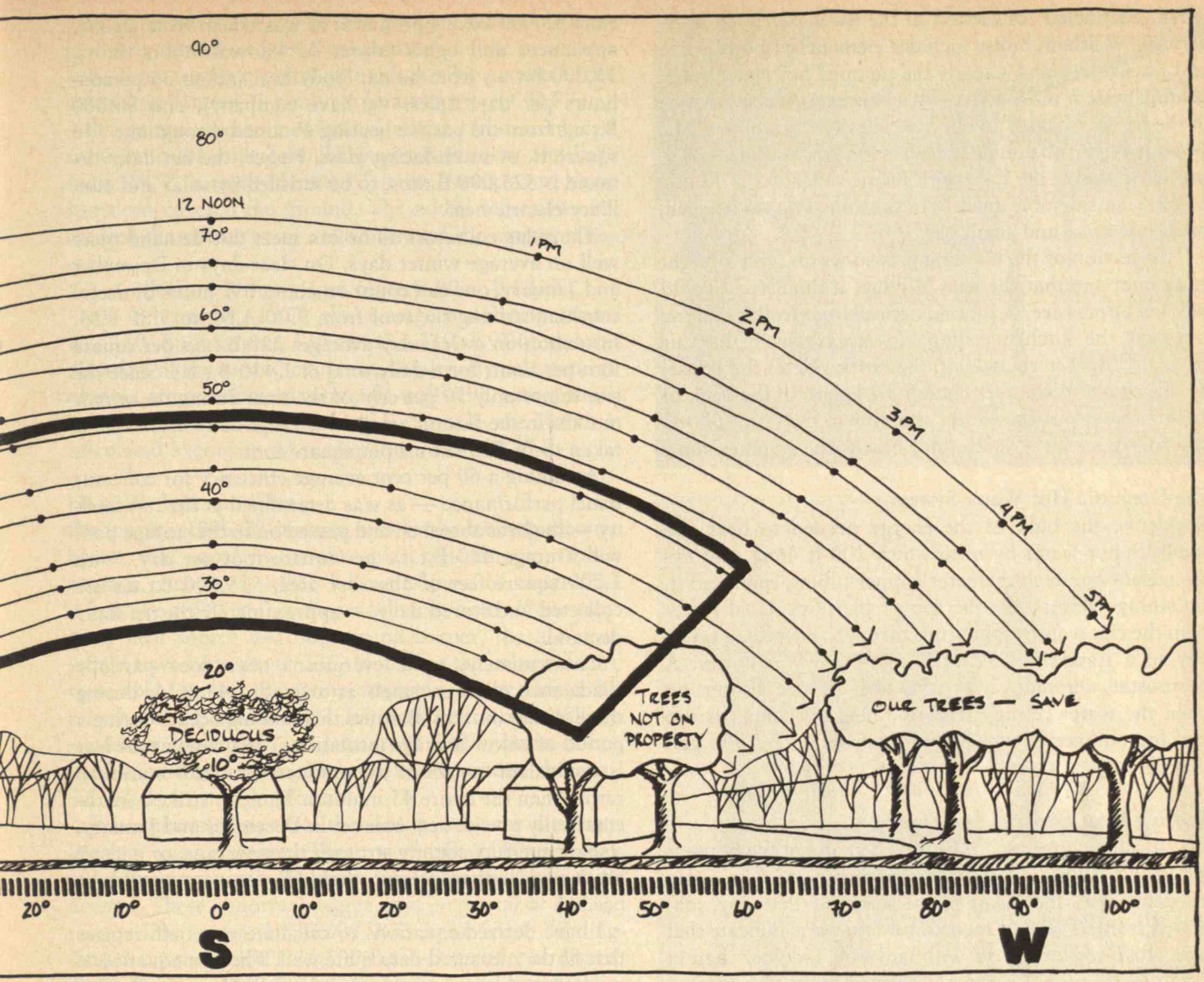
A workman installs siding on the west wall of the 12-by-12 ft. test house. Four solar collectors are in place on the roof, and three, still covered with protective paper, are mounted on the south wall. (Photo: M. Hyman, Jr.)

Three of the sides of the pool are portions of the house foundation; the fourth is a concrete wall cast across the basement. The bottom of the pool is 2 ft. below the basement floor level to prevent excessive head pressure against the free-standing side. The water is held in a 24-mil-thick vinyl liner, which is insulated from the sides and bottom of the pool by 6 in. of Styrofoam, and a similar thickness of Styrofoam also covers the top of the pool.

Warming the Store and Heating the House

Solar heat gathered by the collector panels is transferred as available and needed to the water in the storage pool by an automatic system composed of two heat sensors, a differential switch, and a water pump.

One heat sensor, emplaced in the absorber plate of an upper solar collector, sends temperature data to a control switch, called a differential control, in the basement. The other sensor, placed at the bottom of the storage pool, sends its temperature data to the same differential control. When the absorber plate sensor registers about 15° F higher than the pool sensor, the differential control switches on a ½-horsepower centrifugal pump. The



pump draws the cooler water from the bottom of the pool and forces it up and through the solar collectors where it is heated by the warm absorber plates. This heated water returns to the basement where it empties into the top of the storage pool.

The pump continues to operate until the absorber plate sensor drops to within 3° F of the pool sensor temperature. At this point the differential control switches off the pump. Simultaneously, a solenoid-controlled air valve, connected into the water channel at the attic peak, opens. The open valve admits air into the collector water system, and the water drains down into the storage pool.

Heat is distributed throughout the house by circulating hot water from the upper part of the storage pool through baseboard radiators. There is very little difference between the operation of the radiator system in our solar home and in a conventional home heated with forced hot water. Indeed, the only departure from the ordinary is that the radiator surface area is about twice as large as is usual. This extra area permits the use of heating water at temperatures lower than normally used in a fossil-fueled heating system.

The house is divided into two heating zones — north and south — each of which is equipped with its own clock thermostat and independently pumped circuit of baseboard radiators. We set the heat for 68° F during the daytime and for 60° F at bedtime. When the air temperature in either zone drops below the preset point, the thermostat monitoring that zone switches on a circulating pump that forces water through the radiators in that zone.

The thermal storage pool is considerably larger than those used in most other solar installations and can usually provide a comfortable level of heating over five sunless winter days. During more extended sunless periods, a 9-kw electric hot water heater can heat the water en route to the baseboard radiators. If the house feels too cold, a switch in the dining room can be snapped on to activate this auxiliary heating unit; this function could be automated with thermostatic control.

A Passive Element

Solar heating systems using either pumps or fans to move the thermal fluid through collectors and dwelling are termed *active;* those systems depending solely on the un-

aided, channeled convection of the fluid are called *passive*. My Waltham house includes elements of both active and passive systems. Clearly the pumped hot water space heating system is an active type; however, the south side of the house includes an effective passive component. The 146-square-ft. of double-glazed windows and large sliding glass doors on the south-facing side of the house admit a considerable amount of sunshine into the kitchen, breakfast area, and small den.

This section of the building gets so warm with a bright midwinter sun that the heat buildup, if unabated, would become oppressive. A thermostatically-controlled electric fan near the kitchen ceiling blows excessively hot air through a duct in the wall to the north side of the house. A 3-ft. roof overhang extending the length of the back of the house permits the winter sun, low in the sky, to flood into this area of the house, but blocks the summer sun.

The Domestic Hot Water System

We derive the bulk of the energy needed to heat our domestic hot water by means of a 200-ft.-long heat exchanger of one-inch-diameter copper tubing emplaced in the storage water near the top of the pool. Cold water from the city water supply runs through this tubing on its way to a standard 4.5-kw electric hot water heater. A thermostat automatically turns the electric heater on when the water coming from the heat exchanger is too cool for our needs, which total approximately 100 gallons per day.

Figuring Heat Demand and Supply

The calculated gross space heating demand of the house is 16,500 B.t.u.s per degree day. The degree days in a day are defined as the mean temperature of that day subtracted from 65° F. My records for two years indicate that an average winter day in Waltham is 4° F colder than at Logan International Airport in Boston. Thus, the average January day in Waltham has 40 degree days, requiring 660,000 B.t.u.s to heat the house.

In addition, heating 100 gallons of domestic hot water daily requires 75,000 B.t.u.s. If the heat store in winter is able to supply 60 per cent of this domestic hot water demand, an additional heat drain of 45,000 B.t.u.s is imposed.

From this daily 705,000 B.t.u. demand we may subtract 85,000 B.t.u.s produced as waste heat from electric appliances and lights (about 25 kilowatt-hours daily), 15,000 B.t.u.s from human body heat (about 36 person-hours per day, unless we have company), and 80,000 B.t.u.s from the passive heating obtained through the 146 square ft. of south-facing glass. Hence, the net daily demand is 525,000 B.t.u.s, to be satisfied by solar and auxiliary electric heat.

The solar collectors alone can meet this demand quite well on average winter days. On clear days in December and January, one can count on about 6½ hours of useful sunshine striking the roof from 9:00 A.M. to 3:30 P.M. Insolation on a clear day averages 220 B.t.u.s per square foot per hour, for a daily total of 1,430 B.t.u.s. Since the sun shines only 50 per cent of the time during the winter months in the Boston area, the average daily insolation is taken to be 715 B.t.u.s per square foot.

Assuming a 60 per cent average efficiency for collector panel performance — as was determined at the test facility — the heat absorbed and passed on to the storage pool will average 430 B.t.u.s per square foot per day. With 1,200 square feet of absorber area, 515,000 B.t.u.s are collected and stored daily — approximately the net daily demand.

Unfortunately, some evergreens next door partially shade the collector panels at around 2:45 P.M. during these winter months. Because this shading occurs during a period of below-average insolation, I assume that the loss is equivalent to about 30 minutes of useful sunshine, rather than the entire 45 minutes. Thus, to strike a mathematically precise heat balance in December and January, a solar intensity slightly stronger than average, or a panel efficiency slighter greater than 60 per cent would be needed.

I have derived equations to calculate panel efficiencies that fit the measured data quite well. The first equation is used when the ground outside is bare and free of reflective snow:

$$\text{Collector efficiency (per cent)} = 90 - 0.45\Delta T,$$

where ΔT is the difference between the absorber plate temperature and the outside air temperature.

The average temperature of the storage pool on December 1, 1976, was 128° F; on January 1, 1977, it was 96° F. With the use of this efficiency equation, and with measured data on insolation and degree days, it was pos-

Date (1977)	Average pool temp. (°F)	Calculated average pool temp. (°F)	Hours of effective sunshine	Degree days	ΔT	Calculated solar panel efficiency (per cent)	Insolation (B.t.u.s per sq. ft.)	Solar panel input (B.t.u.s per sq. ft.)	Total solar panel input (1,000s of B.t.u.s)	South window input (1,000s of B.t.u.s)	Waste electricity and people heat (1,000s of B.t.u.s)	Total heat input (1,000s of B.t.u.s)	Space heat demand (1,000s of B.t.u.s)
2/17	114	113.4	7	54	97	58	1,540	893	1,072	180	100	1,352	891
2/18	116	115.9	7	49	95	58	1,540	893	1,072	180	100	1,352	808
2/19	119	119.2	0	41	—	—	0	0	0	0	100	100	676
2/20	115	114.0	0	39	—	—	0	0	0	0	100	100	643
2/21	110	109.2	3	42	81	63	660	416	499	77	100	676	693
2/22	109	108.5											

sible to calculate the day-by-day changes in the pool temperature. Actual measured temperatures in the pool were very close to these calculated values. For example, the calculated January 1 pool temperature was 94.3° F.

A significant amount of light is reflected from a cover of snow onto the collectors. Throughout January and February 1977, a thick blanket of snow from two to three feet deep covered the ground. The added reflectivity increased the efficiency of collection and the equation became:

Collector efficiency (per cent) = 90 − 0.33ΔT

On February 1, 1977, the average pool temperature was 110° F; on March 1 it was also 110° F. With the application of the second equation, day-by-day calculations of pool temperature variation fit well with actual measured changes in temperature. For example, the March 1 calculated average pool temperature was 108.5° F.

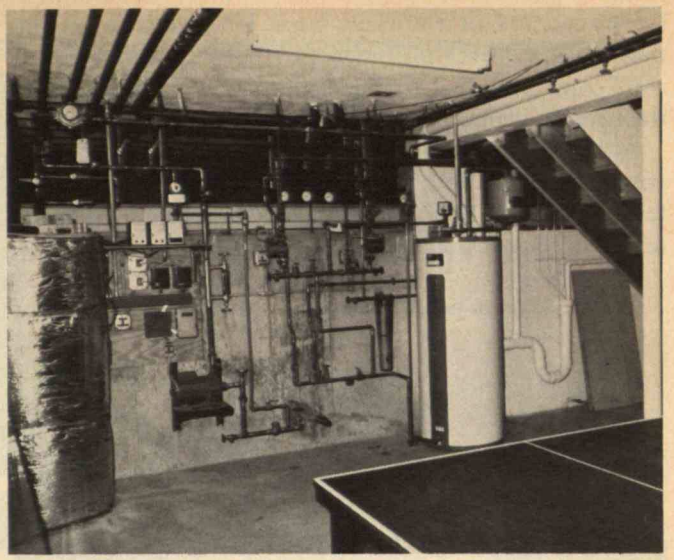
How We Did and Why

During the 1976-77 heating season the backup electric heater that supplements the solar collectors for space heating consumed 1,901 kilowatt-hours of electricity, worth about $95 at 5 cents per kilowatt-hour. If our auxiliary heat source had been an oil burner, the fuel cost would have been about $35. Note that the solar systems were able to meet all heating demands except during the months of December (792 kilowatt-hours of auxiliary electricity consumed) and January (1,109 kilowatt-hours used). January 19 was the last day we needed the auxiliary heat to stay comfortable.

It is interesting to trace the reasons why the auxiliary heating was necessary. There were about 10 per cent more degree days in Waltham for December 1976 than normal. These abnormal degree days — a total of 111 — required an extra 1,830,000 B.t.u.s of space heating (based on the house's 16,500-B.t.u.-demand per degree day). There were 19.5 fewer hours of useful sunshine in December than expected: only 73.5 total hours instead of 93. This deficit translates, at 60 per cent efficiency, into a shortfall of 3,090,000 B.t.u.s, or a total loss of 4,920,000 B.t.u.s.

I noted that during December the average storage pool temperature dropped 32° F, from 128° F to 96° F. This loss is equivalent to 4,260,000 B.t.u.s, because there are 133,000 pounds of water in the storage pool. The 792

Pool heat loss (1,000s of B.t.u.s)	Domestic hot water use (gals)	Calculated hot water heat demand (1,000s of B.t.u.s)	Solar input for domestic hot water heat (1,000s of B.t.u.s)	Total heat demand (1,000s of B.t.u.s)	Net heat gain (loss) (1,000s of B.t.u.s)	Pool temp. gain (loss) (°F)
37	140	105	85	1,013	339	2.5
38	110	84	69	915	437	3.3
40	130	98	82	798	(698)	(5.2)
37	100	77	63	743	(643)	(4.8)
34	80	63	48	775	(99)	(0.7)



Top: The concrete wall supporting all the plumbing is the east side of the 16,000-gallon storage pool in the basement of the house. To the right and under the stairs stands the auxiliary electric heater that supplements the solar space heating system; to the left is the domestic hot water auxiliary heater, well insulated to minimize heat loss. The many gauges aid in monitoring the system — a more complex array than the average homeowner would need.

Bottom: A modern kitchen and breakfast area are part of the passive solar collection system. The glassed area to the right (south) opens this part of the house to sunlight. The fan that blows warm air to the front of the house can be seen at the top of the interior wall to the left. (Photos: L Phillips)

Left: A "page from the notebook" containing the author's extensive data, which show, from left to right, steps in calculating the performance of the heating system. Since February 19 and 20 were sunless, the quantity ΔT — the difference between absorber plate temperature and outside air temperature — was meaningless: the pertinent spaces in the table were left blank. Note that ΔT is 5° F less than the degree data indicate because outdoor temperature during the collection hours is greater than the daily average.

kilowatt-hours of electricity used for auxiliary heating during December contributed 2,690,000 B.t.u.s, so that a total contribution of 6,950,000 B.t.u.s was used to meet the heating demand for that month.

Although at first glance there appears to be an extra contribution of about 2,000,000 B.t.u.s, recall that the afternoon shading of collector panels caused a loss of about one-half hour average sunshine, or 1,230,000 B.t.u.s at the prevailing insolation rate. Thus, only 800,000 B.t.u.s are left to be accounted for, and I believe that this extra demand can be explained, at least in part, by a collector efficiency somewhat below 60 per cent because of the unusually cold weather.

In January 1977, there were 1,481 total degree days, about 19 per cent more than normal. The extra 241 degree days required an extra 3,980,000 B.t.u.s for space heating. The amount of useful sunshine was well above normal for January, some 112 hours instead of an anticipated 96 hours. However, one doesn't heat with averages: we didn't have it when we needed it most. Only 40.5 hours of useful sunshine occurred during the first 16 days of January, a deficit of 7.5 hours, which translates into a deficit of about 1,120,000 B.t.u.s in our collector. During this same period of solar shortfall, there were 740 degree days — 100 degree days above normal. Thus, over the first 16 days of January, the house had a space heating demand of 2,770,000 B.t.u.s more than normal.

The storage pool dropped 5° F, equivalent to 660,000 B.t.u.s, and we used 903 kilowatt-hours of auxiliary electricity, or 3,070,000 B.t.u.s, for a total thermal input of 3,730,000 B.t.u.s. While at first this figure seems to indicate an excess of 960,000 B.t.u.s beyond a perfect balance, the ½-hour-per-day shading accounts for 630,000 B.t.u.s, and the remaining 330,000 B.t.u.s may be explained by the lesser collector efficiency associated with excessively cold weather.

In general, the solar heating systems performed much as anticipated — the house stayed comfortably warm during an average winter's day, maintaining an upper pool temperature of 110° F and a mid-depth water temperature of 100° F. However, when the outside air temperature hovered in the 0° F to 20° F range, we found an upper pool temperature of about 125° F was needed to counterbalance the higher thermal loss to the cold outside air.

In all, to heat the house comfortably through an accumulation of about 6,500 degree days from October 1976, through April 1977, required about 107,000,000 B.t.u.s. About a third of this thermal demand was satisfied by heat sources other than the main, active solar heating system. Auxiliary backup electricity (1,901 kilowatt-hours) contributed 6,500,000 B.t.u.s, waste heat from appliances and people, 21,200,000 B.t.u.s, and passive solar heating, 9,600,000 B.t.u.s — a total of 37,300,000 B.t.u.s.

When added to the auxiliary electric heater input of 6,500,000 B.t.u.s, the total net annual heating requirement came to 79,500,000 B.t.u.s. Thus, our solar heating system supplied 92 per cent of the net heating requirements of our home, equivalent to the consumption of about 870 gallons of No. 2 fuel oil in an average home oil burner, worth about $435 at the current price of around 50 cents per gallon.

In addition to space heat, our system contributed 64 per cent of the energy for our domestic hot water in December, January, and February, and about 97 per cent for the remainder of the year. The total auxiliary use for a year was 904 kilowatt-hours, costing about $45. The system supplied us with 30,800 gallons of hot water, which

Date	Degree days	Hours of useful sunshine	Pool temperature (°F) Beg. of month	End of month
Oct. '76	503	97.5	140	136
Nov.	847	107	132	128
Dec.	1,258	73.5	128	96
Jan. '77	1,481	112	96	110
Feb.	1,096	91	110	103
Mar.	773	112	110	146
Apr.	530	Irrelevant	141	142
Total	6,488			

Top: From the front of the house, which looks out on a quiet residential cul-de-sac, the solar collectors cannot be seen. *Center:* No neighbors have objected to the appearance of the back of the house. Some find it visually interesting. (Photos: L. Phillips) *Table:* The month-by-month history of the 1976-1977 heating season, expressed in degree days, amount of effective insolation, and changes in the temperature of the storage pool water.

MIT '78

Articles

Departments

Margaret Compton to the Class of 1938: No Words to Say What M.I.T. Has Meant

Everywhere he goes, alumni — and he sees lots of them — ask Howard W. Johnson, Chairman of the Corporation, about Margaret Hutchinson Compton. He assures them of her health and spirits with relish — "and then comes another anecdote," says Mr. Johnson.

For Mrs. Compton holds "a central place in our hearts . . . profound admiration and deepest affection . . ."

Such sentiments led the Class of 1938, having claimed the new gallery in the M.I.T. Alumni Center in Building 10 as its special 40th-reunion project, to name it in honor of the wife of M.I.T.'s ninth President.

Though the room was temporarily available in October for the Alumni Officers' Conference, the real opening of the Margaret Hutchinson Compton Gallery, Gift of the Class of 1938 — including the inaugural show of "The Compton Years" — awaited a gala reception and dinner at which the Class paid its special tribute to Mrs. Compton on December 2.

Admiration, love, and devotion came from everyone.

Mrs. Laya Wiesner, who holds the role of Presidential wife with greatest ease, gives some of the credit to Mrs. Compton — "such a warm, caring, compassionate person." Mrs. Wiesner remembers her first months at M.I.T. when Margaret Compton "made me feel that I was a very special person to her." Now, 30 years later, Mrs. Wiesner understands Mrs. Compton in a very different way: "She added breadth and meaning to the role of a Presidential wife that have changed the first ladies who have followed her . . . No doubt my pleasure in being the Institute's first lady depends on the spirit, style, and pride which Mrs. Compton demonstrated 40 years ago," said Mrs. Wiesner.

Norman B. Leventhal, '38, speaking for the Class of which he is President, recalled the Comptons as having "a significant role in our lives" and

After accolades from Norman B. Leventhal, President of the Class of 1938, and other distinguished guests, Margaret Hutchinson Compton, whose late husband was President of M.I.T. from 1930 to 1949, wrote to Mr. Leventhal, ". . . if I have given Tech any fraction of what you say, Tech has given me vastly more – a breadth of view, a concept of the universe, . . . above all the friendship of so many truly great people." The Class of 1938 will fund the gallery in the new Alumni Center in honor of Mrs. Compton, and Mr. Leventhal (right, above) gave her a Steuben Glass beaver as a token of their esteem at a dinner in her honor on December 2.

In front of the Harold Brett portrait of her husband, Margaret Compton received members of the Class of 1938 and their guests at the opening of the Margaret Hutchinson Compton Gallery on December 2. Among those present: Norman B. Leventhal, President of the Class; Albert O. Wilson, Class Agent; Haskell R. Gordon, Reunion Gift Chairman; Mrs. Compton's children, Jean Compton Boyce, Mary Evelyn Alderman, and Charles Arthur Compton; her grandchild, Holly Alderman McClellan; and the principal officers of the Institute. (Photos: Roger N. Goldstein, '74).

"She added breadth and meaning to the role of a Presidential wife that have changed the first ladies who have followed her. . ."

Mrs. Compton as "a woman who was important to us when we were here as students." Clearly those recollections have lived on with other members of the Class, too; for Mrs. Compton was the center of attention and animated conversation throughout the evening.

James R. Killian, Jr., '26, Honorary Chairman of the Corporation — he worked as Dr. Compton's assistant throughout World War II and succeeded him when Dr. Compton was called to Washington at the end of the war — spoke of Mrs. Compton's devotion to women students which led to the first women's house at M.I.T. and to the interest of the late Mrs. Katherine Dexter McCormick, '04, in women's housing; of her concern for foreign students at M.I.T. and throughout Greater Boston which led to the creation of a foreign student center in Cambridge; and of her delight in contacts with students "which made the President's House a place of resort and warm hospitality for young people."

But most of all, said Dr. Killian, was her "unquenchable devotion" to Karl Compton, "the sum of Margaret and Compton being greater than its parts."

Her "glowing mind and spirit have warmed the air above us. . . . She has by example and speech helped give elevated values to this institution . . . a symbol of the institutional qualities we most embrace," said Dr. Killian.

The accolades left Mrs. Compton deeply moved. "If I've meant something to M.I.T." she said, "it's a fraction of what M.I.T. has meant to me. . . . the great people . . . their devotion . . . the immensity of their ideas . . . the intellectual and spiritual strength . . . There are no words to express all that," she said. — *J.M.*

"The Compton Years," the opening exhibition in the Margaret Hutchinson Compton Gallery, celebrates the many sides of M.I.T.'s ninth President in more than 50 photographs from the files of M.I.T. Historical Collections: as a member of the Wooster Academy baseball team . . . in his physics laboratory . . . and leading a family excursion on the trails of Mount Rainier. There are also family memorabilia, including the charming photograph (right) of Margaret Hutchinson in 1920.

Compton Gallery Exhibits: "To Show the M.I.T. Community to Itself"

What are Virginia Gunter's goals as Manager of the new Margaret Hutchinson Compton Gallery? To enable the M.I.T. community and visitors to view various aspects of its activities: exhibits will include a broad range of topics (photography, computation, perhaps the development of solar energy research or some other science or engineering discipline) focussing on current campus activities, alumni, and significant events in M.I.T.'s history, "We are interested in both community and alumni participation," says Ms. Gunter.

As Gallery Manager, Ms. Gunter will research and develop the exhibits. "I will rely heavily on the scientific and technical knowledge of others while doing the overall planning and selection," she says.

Ms. Gunter began her exhibition curatorial work in museums; her credits include an exhibit at the National Collection of Fine Arts and a large centennial exhibit for the Boston Museum of Fine Arts, called Earth, Air, Fire and Water: Elements of Art. She has been Director of Exhibitions at Massachusetts College of Art and taught a course there on the presentation of exhibitions.

"Exhibition design is a field of study," she notes. "It deals not just with technical problems but with the educational process. The point of view of the visitor must be considered: what is the best way to present information in a clear way?"

Around the large space of the Compton Gallery itself is a corridor to be used for small exhibits, based on a timely and flexible response to Institute interests.

Plans for the gallery include an exhibition, Edgerton's Stroboscopic Projects, which will show selections from 40 years of Institute Professor, Emeritus Harold E. Edgerton's investigations. This will be followed by an exhibition about the founding and development of the M.I.T. Center for Advanced Visual Studies (a vision of Gyorgy Kepes, Center Founder and Institute Professor, Emeritus) that coincides with a Hayden Gallery retrospective of Kepes' paintings.

How a Professorship Brings "Risk Capital" to Education

What does it mean to have an endowed chair at M.I.T.?

Freedom — and security . . .

. . . Freedom to invest money in things which no research sponsor or academic budget will let you buy.

. . . Security in the knowledge that long-term — if modest — funding is assured for special projects and activities.

The funds behind endowed professorships at M.I.T. are enough to provide both salary and some discretionary expenses to the fortunate incumbents. Thus a named chair at the Institute is both an honor and an opportunity, as three distinguished holders of such professorships described to members of the Development Committee of the M.I.T. Corporation at its annual meeting late last fall.

Ernest G. Cravalho, who is Matsushita Professor of Mechanical Engineering in Medicine, says he thinks "the undergraduate is the underprivileged child of higher education," and he's tried to remedy that with his discretionary funds. For example, he helped one undergraduate live in New Jersey last summer to work on new compounds to protect biomaterials during freezing; the needed facilities were available only at Rutgers University.

His Matsushita Professorship also assures him of "mobility," says Professor Cravalho — a chance to take on such a chancey assignment as developing a new curriculum in medical engineering and medical physics — "a whole new program for a profession that doesn't yet exist." He wouldn't risk that without the assured support of the professorship.

Nobelist Samuel C. C. Ting, who holds the Thomas Dudley Cabot Institute Chair, works with expensive high-energy equipment at C.E.R.N., the European nuclear center near Geneva. He's used extra funds from the Cabot endowment so that students and junior faculty can travel to Switzerland, sharing the experience of this unusual research.

Changes in the ocean happen slowly, and the "annual funding cycle of Washington is not well matched to this slow pace of oceanography," says Carl I. Wunsch, '62, Cecil and Ida Green Professor of Oceanography. So he cherishes the Green Professorship because it brings with it "money we don't have to justify on a year-to-year basis." Professor Wunsch also uses his Green Professorship funds to help students travel to distant research sites and to work on special projects where there is a high risk of failure. If the project fails, the student's reputation isn't tarnished as it would be if he had to report to a government sponsor, says Professor Wunsch.

The Leadership Campaign, Reaching $150 Million, Claims New Energy and a Broader Target

Just past the half-way point in time, the five-year Leadership Campaign has reached two-thirds of its $225-million goal, a total of $151 million since April, 1975.

That puts the Campaign ahead of schedule — "a remarkable achievement by any standards one would apply," says President Jerome B. Wiesner. But he and Howard W. Johnson, Chairman of the Corporation, are not at all complacent; they've been told ever since the beginning of the Campaign that the last $75 million would be the hardest, and now Dr. Wiesner has an even harder target in mind.

The broader objective of the Institute, he says, should be not only to ensure that we reach the $225 million goal by 1980, "but to see if we can press beyond; and, most importantly, to raise the annual support for the Institute from external sources to a significantly higher level."

Given those ambitious targets, says Mr. Johnson, there is no doubt of the need for "a fresh burst of energy." Accordingly, Dr. Wiesner has pledged to concentrate his personal efforts to this objective between now and next fall. As the new year began, he set aside most of his internal executive responsibilities — to be assumed by Paul E. Gray, '54, Chancellor. Remaining formally the chief executive officer of M.I.T., Dr. Wiesner will continue his duties as an officer of the M.I.T. Corporation and as Chairman of its Executive Committee, and he will continue to be concerned with long-range planning and program development. But Dr. Gray will chair the Academic, Faculty, and Administrative Councils and "will shoulder all of the management decisions and the responsibilities and contacts of our office," Dr. Wiesner said.

A New Investment Adviser for M.I.T. Endowment Funds

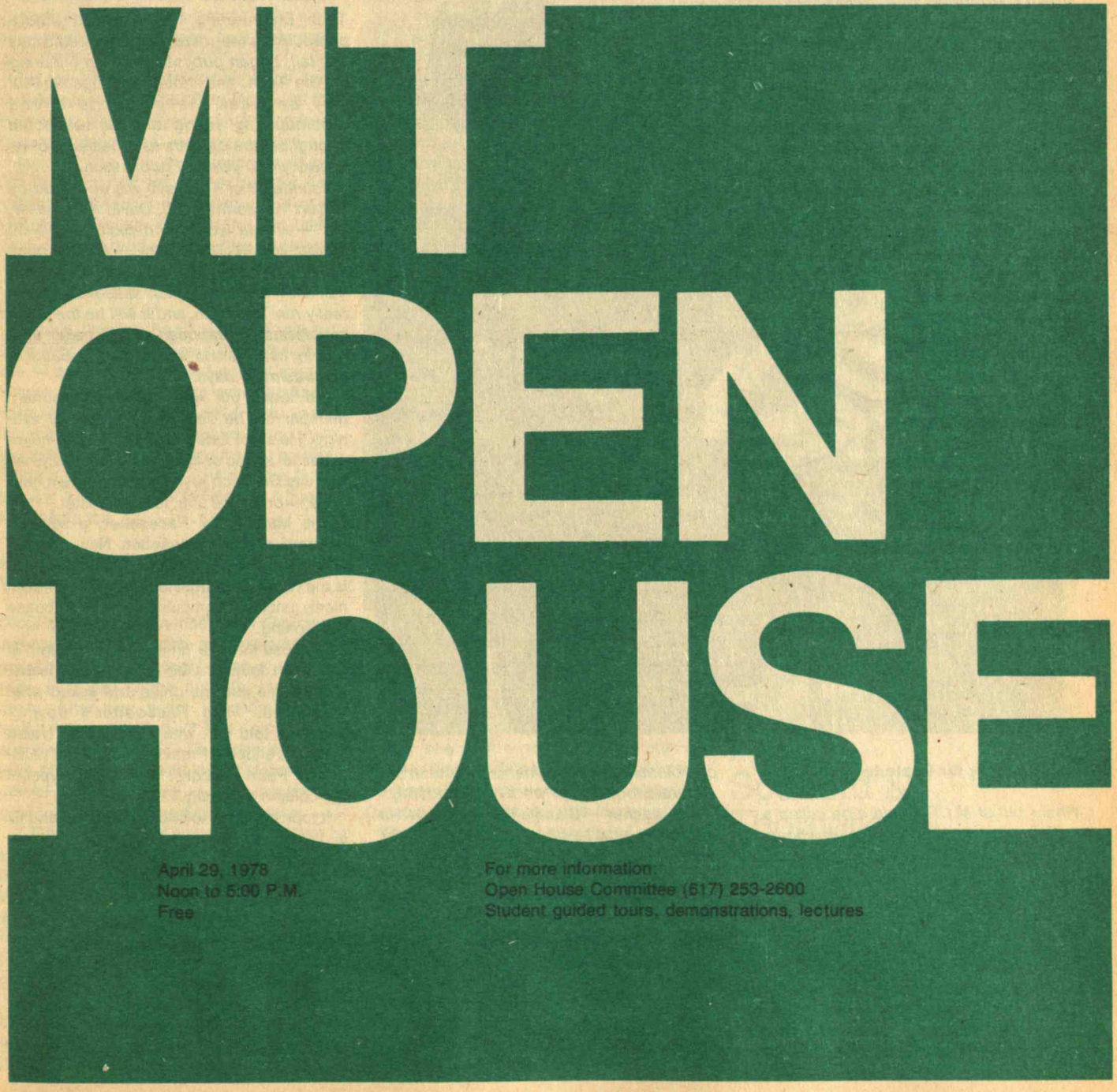
The task of advising Glenn P. Strehle, '58, Treasurer of the Institute, on the management of the securities held in the M.I.T. endowment and other invested funds, was assigned to Thorndike, Doran, Paine & Lewis, Inc., of Boston, a subsidiary of Wellington Management Co., early last fall.

The selection resulted from an exhaustive survey of available services made by Mr. Strehle and his colleagues during the summer. Mr. Strehle said Thorndike, Doran, Paine & Lewis, Inc., emerged as "the best organization to fulfill the needs of the Institute," M.I.T. holds about $350 million in investment securities, excluding real estate investments, and the stewardship of these assets is the responsibility of the Treasurer. Mr. Strehle reports to the Corporation and its Investment Committee, under the Chairmanship of Carl M. Mueller, '41, Vice Chairman of Bankers Trust Co.

The change from the previous adviser — Colonial Management Associates, Inc. — involved one of the largest financial advisory and management accounts in Boston. Mr. Strehle said there has been no change in the basic investment philosophy or the objectives of the M.I.T. funds.

The new investment firm will serve as the manager for a portion of the assets, but the basic investment management policy to "seek total return made up of income and changes in market value" remains unchanged. The primary objective over the long term is "to provide a growing stream of investment returns over time which treats equitably, in inflation adjusted dollars, the present and future needs of the Institute." Mr. Strehle emphasizes that "only earned investment income is distributed to funds used for Institute operations. The need to maintain capital for future growth is an important reason for that policy," he says.

The Treasurer's Report for year 1976-77 showed that investment operations resulted in a modest reduction in the holdings of equities and an increase in the holdings of fixed income securities. Fifty-eight per cent of the investment securities portion of the general investments was in equities as the fiscal year ended, with 42 per cent in fixed-income securities. Despite a decline in the stock market during 1976-77, there was a modest increase in the market value of the Institute's portfolio because of higher bond prices and additions to holdings from gifts and other receipts. — *J.M.*



A Laboratory for Exploring the Piano

Where but at M.I.T. would it be called a "piano laboratory"? Those of us who grew up in homes with pianos know well enough how a piano sounds, how it responds to its keyboard, and how much it can teach about rhythm, melody, and musical style. To enrich the experience of students who haven't had that good fortune, the Music Section in the Department of Humanities now has a what it calls a "piano laboratory" — a room with five modules, each containing a piano. After a lesson or exercise is explained — fingering, rhythm, coordination — the students fan out to the separate modules to work independently.

The teacher — Claudia Von Canon (left in the photo), who has the incongruous title of Technical Assistant — can then work with each student individually by going from one to the next. Her purpose is to help students "learn to use their fingers and to translate theory into sound." That's essential for students who want to go into music theory or history whether or not they ultimately decide to study the piano more seriously, explains Professor Martin D. Farren. (Photo: Calvin Campbell)

Who Really Runs *The Tech*? The Name Is Dymo Mark I 812 Pacesetter

Tech Engineering News, *which disappeared from the roster of student activities last fall, began publication as an offspring of* The Tech, *and though the descendant may be weak the parent is strong —perhaps as strong and as respected throughout the campus as it has ever been in nearly 100 years of publication.*

Volume 98 of The Tech *will be edited by Robert Wasserman, '80. David A. Schaller, '78 — whose words and pictures will be familiar to* MIT 78 *readers — is Chairman. But one night late last year William Lasser, '78, then Editor-in-Chief, discovered who really ran* The Tech, *and it will be the same for Messrs. Wasserman and Schaller as it was for him. Here is Mr. Lasser's account of two traumatic days:*

We found out who the most important member of *The Tech* is last Monday evening. He's not listed in the mast, he never writes an article or takes a picture. But when he quits *The Tech* just about grinds to a halt.

He — or maybe she, for that matter — is a Dymo Mark I 812 Pacesetter, a second-generation photo typesetter. Now that the whole world is becoming computerized, so is the newspaper business, which works out nicely until the computer decides to cease functioning.

I noticed that the "in the news" column of *The Tech* looked a bit different last issue, and I came into the office and asked what happened. "The Pacesetter's down," someone told me, with a tone that rivaled "They've shot the President" or "They've attacked Pearl Harbor." "We had to typeset the column manually."

It took two days to find the problem and fix it. What was wrong? You shouldn't have asked. I did, and got the following response: "The section of the read-only memory containing the microcode died. The microcode informs the computer of the instruction set. The computer couldn't interpret the instructions."

I didn't understand that, so they told me "it was a logic problem," which seemed to make the Pacesetter fit in with the rest of the newspaper. "One of the problems is that the machine's design is ancient, so the diag-

nosis was difficult," the local computer expert told me. Visions of the Egyptian pyramids or the Roman Coliseum flashed through my mind; but "ancient" in the computer typesetting business, I was informed, is about five years ago.

For two days the newspaper office most closely resembled the War Room at the Pentagon, with everyone developing contingency plans and wearing worried expressions. But, like the Grand Old Party, *The Tech* survived yet another disaster. The patient is alive and well now, and it even typeset this issue. But just for old times sake, I asked production to typeset this on an IBM Selectric instead of using the Pacesetter. Sorry, they said — it couldn't be done.

Frankly, I'm glad the Pacesetter finally did something wrong. You see, that's the problem — all of us writers and editors are just human, but the computer never makes a mistake, never gets tired, never gets angry. It just seems to smirk at you while you try to be creative. But now I know it's not perfect. It had a *logic* problem — what more fitting fate for a computer? Computers, I guess, are people too.

A Death in the Family of Student Publications: *Tech Engineering News*

Older alumni will remember *Tech Engineering News* — a monthly student-produced magazine of technology — as a spritely, even vital part of the Institute scene. No more. After two years of sporadic and lackluster publishing, *T.E.N.* announced suspension of its 1977-78 issues last summer. And in November it lost its status as an official student activity — and thereby its right to an office in the Student Center.

T.E.N. was founded just after World War I, and it enjoyed influence and prosperity into the 1950s and even early 1960s. It was the victim of a lack of student interest — another way of saying, probably, that its format and role were too apolitical for today's generations of politically-conscious undergraduates.

Forrest N. Krutter, '75, who was Editor-in-Chief of *T.E.N.* in 1974, attributed the difficulties to declining advertising support; but he admitted in his last editorial in January, 1975, that "the 1970s have been a time of great trouble for college engineering journals."

Yet curiosity and demand were high in 1977. A sad sight early in December: some 2,500 copies of *T.E.N.* — surplus back issues removed from the vacated Student Center offices — were put out in the Lobby of Building 10, where two decades before hawkers had sold hundreds of copies of the magazine every month. The 2,500 copies were gone in an hour.

A New Record for the Ugliest Man

More than $8,240 came to the American Red Cross from M.I.T. students this fall, the contributions in the form of votes — one vote = one cent — for the ugliest man on campus late last fall. It was a record total in the annual contest managed by Alpha Phi Omega, the national service fraternity.

The winners were Lawrence E. DeMar, '79, David S. Browne, '78, and J. Spencer Love III, '77, costumed as "The Hump" — pan-handling, scruffy, hump-backed characters — assisted by numerous "humplets." Their total was also a record — $2,090. Mr. Browne told The Tech *that the contest was "a hell of a lot of fun . . . a great way of meeting people," and Mr. DeMar agreed — but added that it was "an incredible time-sink." (Photo: Douglas Birdwell)*

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One Beacon Street, Boston, Mass. 02108

What does the uncertainty of future energy supplies mean to the management of American free enterprise? New challenge and new opportunity, said nearly a score of speakers at a December symposium of the M.I.T. Alumni Center of New York. Over 200 executives from throughout the Northeast attended; speakers included Professor John J. Donovan of the Sloan School of Management and Ben C. Ball (right), Vice President of Gulf Oil Corp. who is Adjunct Professor at the M.I.T. Energy Laboratory.

Co-op Courses Expanding Into an Engineering Internship Program

Course VI-A, the cooperative program in electrical engineering and computer science that is "acclaimed for its excellence throughout the U.S.," is now providing the model for an internship program in six other departments of the School of Engineering.

Much as they do in Course VI-A, students in the other new internship programs will spend three summers and one term in residence at a company or government agency on the way to combined bachelor's and master's degrees in five years. They will receive academic credit as well as salary for their off-campus work.

The idea is to place students "in rewarding 'real-world' work assignments that extend the learning experience into areas not available at M.I.T.," says Joseph M. Sussman, Ph.D. '68, Associate Dean for Educational Programs in the School of Engineering.

Dean Sussman and his colleague, John R. Martuccelli, '53, Director of the Engineering Internship Program, are now seeking participation of companies — mostly in New England — in the pilot stage of the Program, so that students can be enrolled and have intership experience during the coming summer. There will be extensive faculty participation, with a faculty representative assigned to each participating company.

MacEachen: Separatism Threatens Traditional U.S.-Canada Solidarity

Though less than 20 per cent of Quebec voters are pledged to the province's separation from the Canadian confederation, the election of a provincial government committed to that goal is "a very dangerous situation" for Canada — "a basic challenge to the existence of Canada as an independent nation," says Allan J. MacEachen, '53, Deputy Prime Minister.

The strength of the government — and even of the country itself — is sapped by the constant tension between the need for national strength and for cultivating the linguistic and cultural aspirations of the minorities, Mr. MacEachen told members of the M.I.T. Corporation in a luncheon address on December 2.

(Mr. MacEachen, who studied economics at M.I.T. but does not hold an Institute degree, was elected to Term Membership on the Corporation in 1975, when he was Canada's Secretary of State for External Affairs.)

The U.S. has a major stake in the outcome, said Mr. MacEachen. Canada is the largest single customer for U.S. exports, and the two nations "share identical international goals and democratic traditions and institutions." The U.S. needs "a strong, independent . . . Canada . . . to participate as a partner in world affairs."

03

We reluctantly announce to our distinguished group of oldest M.I.T. alumni the sudden critical illness of our loyal classmate, **Andrey A. Potter**. Only last month, we proudly announced his zenith in electrical engineering honors at Purdue University with the dedication of a $6 million group of buildings for future teaching and research in his honor. Andrey recently suffered a fall that has now confined him to a wheelchair and will restrict his customary daily visit to his office at the University from his attractive campus home. Accordingly classmates, your cheeful notes and greetings to Andrey will be warmly appreciated. His address is: 517 Russell St., West Layette, Ind. 47906 — **John J. A. Nolan**, Secretary, 13 Linden Ave., Somerville, Mass. 02143

08

We are sorry to report the death of another classmate. **Roger C. Rice**, a civil engineer, died August 12, 1977, as reported by the Los Banos Convalescent Hospital of California. We now have 19 living members of M.I.T. '08. The oldest is **Fred W. Lyle**, who is 93 years old, born December 7, 1884. The average class age is now 90.1. — **Joseph W. Wattles**, Secretary, 600 Washington St., Wellesley, Mass. 02181

12

I regret very much having to report the death of **Bill Collins** on October 10, 1977. During World War I, Bill was a member of the U.S. Army Engineers and had charge of planning and building roads at Forts Devens and Mead. He founded the Hornell Construction Co., of which he was President and owner. This company was strong on road construction and built many sections of the highway systems in upstate New York. He was President and Chairman of the First State Bank of Canisteio until retirement in 1972, and a charter member and first President of the N.Y. Chapter of the Association of General Contractors of America. He was very active in civic affairs, serving as Director of St. James Mercy Hospital and the Hornell Children's Home, and as a member of the Hornell Planning Board.

Bill was always very proud of his M.I.T. education and was a generous contributor to the Alumni Association.

He leaves a daughter, Mrs. Joan Nugent of Hornell, two granddaughters, two great-grandchildren, and several nieces and nephews. — **Larry Cummings**, Secretary, R.R. 4, Connersville, Ind. 47331

13

George Capen, Secretary of the Class, was hospitalized for two weeks this winter and released December 8. His daughter, Janet Ruder, reports that Mr. Capen "seems fine, though a bit weak." He sends the Class his best wishes and expects to be reporting their activities as usual in the next issue. — *S.F.*

14

Israel H. Lovett wrote in November that after being on the faculty in electrical engineering for 40 years he retired as Professor and Chairman of the Department at the Rolla campus of the University of Missouri he retired some years ago and continued to live in Rolla. Eventually he found that maintaining his home there was becoming too much of a burden, so he moved to a residence where about everything is furnished, including opportunities for travel. Rael's new address is John Knox Village, Waynesville, Mo., 65583.

All that **Alden Waitt**'s November letter permits me to say about the very successful exhibit of his landscapes is, "If you are overly short of news items, a very short note to the effect that I have just (October 23 thru November 20) had a retrospective exhibit representative of my work from 1955 to date, including over 125 paintings and four lithographs." Alden wrote also that he and Kathryn celebrated their 60th anniversary on November 11 with a party for 40-odd friends at the Fort Sam Houston Officers Club. Alden recalled that on their first anniversary he was at A.E.F. Headquarters at Chaumont, France, on his way back to the States and managed a stop in Paris for a celebration.

Mrs. J.E. Schobinger of Granby, Conn., has kindly provided information about her father, **Ernest W. Mann**, whose death last September was mentioned in the January class notes. Ernest was born in Central Falls, R.I., and was 85 when he died. He lived in the Braintree and Duxbury area most of his life and moved to Granby in 1975. Before his retirement in 1957 he had been for 20 years a purchasing agent at the Bird Machine Co. of South Walpole and was a member of the Unitarian-Universalist Church. In addition to Mrs. Schobinger, Ernest is survived by another daughter, Mrs. Gertrude Sinott, of Lawrenceville, N.J. — **Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, Conn. 06119

16

We are planning again for our annual reunion — this year our 62nd — at Chatham Bars Inn, June 6 to June 8. If anyone has other ideas on this reunion or future reunions we will be glad to consider them. Those who have been attending regularly like the idea of going to Chatham Bars Inn annually. Some come for two days, or one day, or one meal only, but they keep coming back.

I had a nice Christmas card with notes from Jessie (Mrs. **Thomas) Brophy**: "I enjoy reading the Class Notes and am so glad you are keeping well." . . . From **Nat Warshaw**: "Last winter was so tough I am going to warmer places at my doctor's suggestion this time. Perhaps I can make the next reunion since I missed it in 1977." . . . Cards were also forthcoming from Mertie and **Allen Giles**, Frances and **Paul Duff**, **Maury Holland**, **John Gore**, **Shatswell Ober**, and **Art Shuey**.

A letter from **Val Ellicott** reports: "I enjoy the reunion picture you send to me each year. The latest is a fine picture and shows a pretty sturdy group for a class 61 years out. I wish I could have been with you at the time. Last September the Ellicotts celebrated the 100th anniversary of their summer place in the mountains of Eagles Mere, Pa. It is not often nowadays that a place stays in one family so long. I see that our class still has about 140 living members. I bet that's quite a bit more than the actuaries would have predicted. My best to you and all the other 139."

We would appreciate hearing from you with news items for the column. Keep breathing! — **Ralph A. Fletcher**, Acting Secretary, P. O. Box 71, West Chelmsford, Mass. 01863

17

Johnnie Debell is doing his best to retire from the many local activities in which he has been involved. Recently he finished writing his contribution of 20 per cent or so to a history of the town of Enfield, Conn. This volume will soon be published. Presumably he included mention of two of his ancestors who settled there at a time when the settlers shared hunting grounds with the Indians. He has resigned his work with the nearby Health and Mental Health Centers, but continues to be involved in town affairs. He is also a Trustee of the Hospital. He and Emmas keep well enough to rake lawns and cook meals at their home in East Longmeadow. They also enjoy visits from their "kids."

Betty Hulburd, widow of **Phil Hulburd**, recently underwent a major operation and shortly thereafter broke her hip. She has been in two hospitals but hopes to return soon to her home in Meriden, N.H., and later, have further treatment at the Mary Hitchcock Hospital in Hanover, N.H. We extend our sympathy to Betty and best wishes for an early recovery. Phil, you will all remember, was for years Chairman of the Mathematics Department at Philips-Exeter Academy.

Dr. Julian A. Stratton, Class of 1923 and honorary member of Class of 1917, spoke on October 19 to the Cape Cod Alumni at a luncheon at the M.I.T. Historical Collections, giving an informal account of his current research on the early days of the Institute. Since returning to Cambridge from the Ford Foundation in 1971, he has been delving into the history of M.I.T. with a view to writing what he calls the "Biography of the Institute," in which its founding and development will be set forth in the context of the social and educational ideas of the time and against the background of the political and economic climate of the country. Particular attention will be paid to the source of the ideas of William Barton Rogers and those who joined him in promoting the concept of a technological institute in Boston. Dr. Stratton expects also to give much attention to the early

Last October, Ted Bossert, '20, was honored at a reception on the occasion of his retirement as Curator of Portraits of the Hunt Institute of Botanical Documentation at Carnegie-Mellon University in Pittsburgh. He organized the collection of portraits of botanists from around the world and was responsible for the publication of the Biographical Dictionary of Botanists.

curriculum and its evolution over the years. The historical papers of the Institute are unfortunately rather sparse, and the process of seeking out information from sources outside of M.I.T. has been slow, but the manuscript is now under way.

The **Stan Dunnings** and the **Bill Hunters** described their Thanksgiving week at the Elbow Beach Club in Bermuda: "The weather favored us except for one really bad day, when we endured a 'southeaster.' The storm reminded us of the 'northeaster' we had in June on Cape Cod except that this was *hot.* We did a lot of sightseeing, including many historical spots, the Botanical Gardens, Hamilton, St. George, and Somerset. Fortunately, we left a few days before the rioting."

The **Stan Lanes** departed right after Christmas to spend January, February, and March at the Starlite Condominiums in Boca Raton, Fla.

Jim Flaherty saw **Nelson Chase** recently at his home and found him in good spirits, but in need of a little time before starting on a new portrait. . . . **Jim** and **Jesse Rogers** had a ride down Route 1 as far as Foxboro and were amazed at the size of the racetrack and the "Patriots" grandstand, as well as the immensity of the Foxboro Co. layout there.

Our condolences go to **Ossie Holt**, for shortly after his return from the 60th Reunion, Mrs. Holt fell and broke her hip. We hope for an early recovery for her.

Ralph P. Newhall died at his home in Kearsage, N.H., on October 7, 1977. Ralph was a graduate of Harvard in 1915, and of M.I.T. in 1917 in electrical engineering. During World War I he served as a Captain in the 76th Division and continued service for several years in the Signal Corps. He later owned and operated the Russell Hotel in Kearsage until 1960. Our sympathy goes out to his widow, Mrs. Mary Newhall.

We also regret to report the death of **William W. Eaton** on June 1, 1977, in Los Angeles. He served in World War I as a Captain of Artillery in France. Later he was employed by Babcock and Wilcox, and as President of the Forest Lawn Life Insurance Co., of Glendale, California. — **William B. Hunter**, Secretary, 185 Main St., Farmington, Conn. 06032

18

It is mid December. Within the last few days I completed sending season's greetings to all 143 of you in the U.S. and foreign countries. Already I have received dividends in messages from many of you including **Tom Knowland**, **Wilfred Holt**, and welcome news from president **John Kilduff** that he is making a good recovery in Florida.

Dorothy and **Granny Smith** send their usual cheerful message. They mention that "after Granny's heart attack last year, we lead a more relaxed life and sold our boat which needed so much of his time and effort. However, we have tried to keep up our usual activities — military affairs, college clubs, and church work."

Chuck Simpson writes: "Your card brings M.I.T. to life again — and oh! how I wish I could be right in the middle of it again. I am — as usual — right on top! Why shouldn't I be? I'm only 83 and my program calls for a lot more *doing* in the years to come. Because of money — or the lack of it, to be precise — I'll confine my activities to the State of Florida. It's the finest place in the world (and I've looked around most of it)."

Herb Larner, ever-interested in making a better world, had a letter published in the December 4th *New York Times* comparing injustices in South Africa with those in the U.S. He concludes: "How do we differentiate between justice in America and that dispensed in the Republic of South Africa? Kipling wrote a piece about the Colonel's Lady and Judy O'Grady. He reached a conclusion that one might paraphrase in this way: When you get to the facts in the case, they're like a row of pins, for the U.S.A. and the R.S.A. are twins, in the matter of sins."

I am indebted to Katherine **Brewer** for a summary of **George**'s career: "George and I had 50 good years of marriage, with three children, and now, six grandchildren. I was thankful that he did not have to go on alone. He always felt sure that I would survive him — so much so that once in a while, I would remind him that there is no way of knowing the future. George was employed in the Laboratory of the American Meter Co. during most of our married life. Before that, he was with the Erie City Iron Works, working with a type of coal pulverizer. But along came the Depression, and they had to cease experimental work. He was fortunate to get a steady job with American Meter. In later years, we traveled some. We both loved ships, and could take all kinds of rough weather without getting seasick. The ships are gone, now, I think. He had wanted to go on the last voyage of the Queen, but the doctor vetoed that. Our last trip was in '76, a rail trip across Canada — from Toronto to Vancouver and return."

We note with regret that **Arthur C. Hardy** died on October 31, 1977. He was Professor of Physics at M.I.T. from 1922 to 1961, was consultant to a number of companies, author, and inventor. The *Boston Globe* credits him as a "distinguished educator." Professor Hardy leaves his wife, Elizabeth. — **Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Brookline, Mass. 02146

20

Recently I have had the good fortune to gain an insight into the lives and careers of two of our esteemed and admired classmates, which I propose to share with you in the hope that some of you will be inspired to provide me with similar details.

Phil Young of Westfield, N.J., majored in chemical engineering at M.I.T.; upon graduation he went to Eastman Kodak and from there to Exxon as a design and testing engineer. As a result of some work with one of their patent attorneys he was persuaded to study law and eventually became a member of the New York Bar. As a result Phil became head of Esso's patent department, an occupation to his liking so that he remained in that capacity for over 40 years. He retired in 1963 after serving as Secretary of Esso Rand Engineering. Just before settling in New York, Phil married a Texas girl whose first name is Texas, believe it or not. They have two girls, two boys, and several grandchildren. Along the way they acquired a summer place in Vermont, near Manchester, "right in the skiing country," says Phil, "but we do not ski. I cannot abide ice anywhere except in its proper place in a glass." The Youngs now spend some seven months at the old family home in New Jersey and five in Vermont. "I am a lucky one and have had a good life," Phil goes on to say. "Tech meant much to me and although there is much more taught now I feel that I did get a sound foundation. The work I did was interesting and I have met and kept many friends."

The second classmate is **Ted Bossert**. In October a reception was held at the Hunt Institute for Botanical Documentation, Carnegie-Mellon University in Pittsburgh, to honor Ted on the occasion of his retirement as Curator of Portraits.

In recognition of his significant contribution to botannical biography and iconography during his 15 years of volunteer service at the Institute, Ted has been appointed Curator Emeritus. Ted also was a Course X graduate of M.I.T. After a short tenure at Harley Davidson Motor Co. in Milwaukee, he joined Alcoa as a metallurgist. He served as Chief Metallurgist for many years until 1959 when he was elected Vice President in charge of research and development. Shortly before his retirement he received the prestigious William Hunt Eisenman Award of the American Society for Metals for unusually distinguished service in the practical application of metallurgy to the production of metals. Not content to remain idle, Ted voiced an interest in working at the Hunt Botannical Library founded by the Chairman of Alcoa. He organized and built an unparalleled collection of portraits of botanists, from around the world. He also compiled and edited a Biographical Dictionary of Botanists which accounted for more than 14,000 people in the field. Ted

lives at Russlyn Road, Carnegie, Penn., with his wife, Emily. They have a son and two daughters, one of whom lives in Westfield, N.J. (Small world.)

An unusual hobby, one might say, and a far cry, perhaps, from Ted's distinguished career in metallurgy. Speaking of hobbies, **George Wilson**, of Braintree, Mass., mentions that in his active retirement he is pushing no less than five hobbies. We'd like to hear more about them, George. — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, Mass. 01890

21

Your Secretary gets a bonus out of Alumni Fund contributions when classmates add a note on the back panel of the envelope. Four classmates responded this month: **John G. Lee** of Mystic, Conn., wrote: "I'm active in minor local matters, have no technical or administrative jobs, and do some painting." . . . **Al Genaske** of Fryeburg, Maine, reported, "Since returning from Florida last April, we have stuck close to Kezar Lake. We have seen Helen St. Laurent [widow of **Raymond A. St. Laurent**] several times." . . . **Eugene Hardin** of Manhattan, Kan., says, "I had a busy year in 1977. Since retirement from Parsons, Brinkerhoff, Puade and Douglas in 1975 I have been a consultant on hydraulic and sanitary engineering projects for them and others. I spent last spring in San Francisco on one project and this fall in New York on another. I am enjoying retirement immensely — working." . . . **Marshall Winchester** of Windsor, Conn., writes, "I am a retired Supervising Engineer in the Engineering and Loss Control Division of Traveler's Insurance Co. — retired in 1963."

A post card mailed in Florida in late November from **Rufe Shaw** gave sad news: "1977 has been a hell of a year for me. I was operated on for lung cancer, probably successful. My bandages caught fire and I was in the hospital three and a half months. My daughter and only child died of a heart attack while at her desk." Classmates who attended our 55th reunion will remember this attractive daughter, Mary Carretta, who came up to Cambridge to drive the Shaws home after their house was burned and vandalized by arsonists.

A good letter from **Bob Miller** said in part, "The reason you didn't hear from me this fall on our way home from Cape Cod is because we took a foliage trip up into Vermont and then through the Adirondacks to our daughter's in Rome, N.Y. We came down through Pennsylvania and visited other members of the family. While at the Cape we had lunch with the **Whitney Wetherells** and the **Sam Lundens** — also saw **Don McGuire** at the Orleans Coffee Club. . . . We haven't made any plans for a winter trip but we are tempted by an Eastern Airlines trip which would stop at Caribbean Islands and then on to Mexico City where we would visit our daughter, and then return with a stop or two in Florida."

A letter from **Roy Wehe** told of a trip by car to Southern California during October and November after an O.K. from his doctor. "One has to be thankful to recover from a serious illness such as I had in the spring, and be around at 82. In September the Electric Club of San Francisco invited me as a luncheon guest to receive the 50th Year Membership award. Also, my Euclid Masonic Lodge in my old home town of Lakota, N.D., sent me a 50 Year Certificate and pin. After my illness last spring, I resigned from my position as a Public Works Commissioner for the City of San Mateo. The city graciously granted me several separate awards for public services performed."

It is my duty to report the death of **George B. Wetherbee** of Portland, Me., on October 6, 1977. Wetherbee was a marine engineer with Bethlehem Steel, in Quincy, Mass., and moved to Portland after retirement in 1948. He belonged to the Naval Architects Association. The sympathy of the class is extended to his family.

In the January, 1977, issue of *Technology Review* I picked out at random 15 classmates I'd like to hear from. I got about 50 per cent response — not bad. So let's try again with a dozen names: **Robert Barker**, **Ivan Chambers**, **Edward P. Clark**, **Larry Conant**, **Weston Hadden**, **Munroe Hawes**, **Melvin Jenney**, **Alexander Lapointe**, **Leo Pelkus**, **George Schnitzler**, and **Reg Smithwick**. How about it? — **Sumner Hayward**, Secretary, 224 Richard Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden**, Assistant Secretary, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

22

Your Secretary has just received an odd-shaped piece of wood as the writing arm from Room 10-250 — a memento from our lecture periods in physics and electrical theory of long ago. Everyone who comes in the office asks, "What's that?" which gives an opportunity for reminiscence. We are now anxious to see the new finished 10-250 — but the old one will never be forgotten. Were any of you initiated as a shifter in this room?

A note from **Theodore P. Shlikoff** of Guntersville, Ala., informs us he is living with friends and enjoying life but is not physically active.

It is a temptation to comment extensively on a letter received from **William B. Elmer** of Andover. Bill has included a copy of *Ergo* with his comments agreeing with writings in this conservative campus voice. Among the items with which Bill disagrees at M.I.T. are the modern sculptures decorating the campus area.

Horace "Mac" McCurdy has written from Indian Wells, Calif., his Eldorado home. We really missed Kate and Mac at the reunion and hope that we will get together on either the west or east coast before too long, preferably in bountiful Coachella Valley. Mac and Katherine live near Palm Desert, which is beyond Palm Springs.

Frank Kurtz has written from Delray Beach of their trip from Los Angeles on the *S.S. Renaissance* through the Panama Canal to Fort Lauderdale. This sounds like an ideal, restful two weeks' vacation. We hope to see Carlys and Frank in February.

We are sorry to report the death of **Dean K. Worcester**, who was with the New York Stock Exchange for several years as Executive Vice President before joining the law firm of Carter, Ledyard and Milburn in Manhattan. He was Treasurer of the Association of the Bar in the City of New York from 1956 to 1960. He is survived by his wife Eleanor, a son, two daughters, and 12 grandchildren. . . . **Walt Saunders** has enclosed a November clipping and obituary for **Willard B. Purinton** of Augusta, Maine. He had retired as President and Treasurer of Purinton Brothers Fuel Co., was a member and organist for All Soul's Unitarian Church, past Chariman of the Kennebec Valley Y.M.C.A., a member of Augusta Rotary Club and the Kora Temple Shrine, and a former alderman and councilman. He is survived by his wife Dorothy, a son, a daughter, and eight grandchildren. The sympathy of our Class is also extended to the family of **Thomas H. Swisher**, 1065 Questa Dr., Mountain View, Calif.

A pleasant winter of golf and good health to you all — **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

23

Those who intend to arrive early for the 55th Reunion of our Class will find accommodations available beginning Wednesday, June 7, at McCormick Hall on campus.

The social program goes into high gear on Thursday, June 8, with a class dinner at McCormick Hall and Tech Night at Pops, continuing through the weekend. After Technology Day on June 9 with noon banquet at M.I.T. for all alumni, a large number of us will meet at the Lighthouse Inn in West Dennis on the Cape for two days of fun and frolic. **Royal Sterling**, general chairman, reports that by the end of last November, as many as 82 classmates and wives signed up for attendance at M.I.T. and 75 for the Cape — a splendid early response.

The following intend to bring their wives: **W.P. Allis**, **J.W. Beretta**, **S.I. Berger**, **H.L. Bond**, **G.W. Bricker**, **H.A. Bruson**, **M.L. Carey**, **C.V. Chamberlin**, **M.N. Clair**, **A.W. Davenport**, **T.B. Drew**, **R.H. Frazier**, **R.M. Goetchius**, **H. Green**, **E.A. Griswold**, **H.L. Hayden**, **B.B. Joy**, **H. Kalker**, **R.C. Kleinberger**, **F.P. Lange**, **H.A. Lockhart**, **W.S. LaLonde**, **M.C. Magarian**, **C.M. Mapes**, **B.A. McKittrick**, **M.W. Pennybacker**, **J.A. Pennypacker**, **L.H. Poor**, **A.S. Redway**, **J.M. Robbins**, **I. Robinson**, **T.E. Rounds**, **G.A. Rowen**, **P.C. Smith**, **R. Sterling**, **J.A. Stratton**, **L.L. Tremaine**, **W.N. Webster**, **N. Weiss**, **W. Wolfe**.

Single attendees will include **A. Allen**, **E.S. Averill**, **H.D. Chase**, **C.H. Ducote**, **J.A. Frank**, **W.B. Greenough**, **O.L. Hooper**, **O.W. Lowry**, **L.A. Metz**, **L. Oliver**, **A.J. Pyle**, **E.C. Rue**, **D.W. Weeks**.

C.V. ("Shorty") Chamberlin writes that he is still consulting since retiring ten years ago. He's now busy with work for the Children's Specialized Hospital at Mountainside, N.J., but expects to be at the Class Reunion in June.

Edward S. Averell reports that since the passing of his wife in 1969, he's been going it alone, visits his daughter in Cromwell, Conn., to whom he has transferred ownership of his summer place in Pocasset, and looks forward to our Reunion in June.

William S. LaLonde tells us that he and Marion took an M.I.T. Century Club sponsored cruise to the Caribbean and had two weeks of wonderful weather, good food, fine sailing, sight seeing, and relaxation. He plans to be with us all at the Cape and at M.I.T.

John Power Crabb received his B.S. degree in Chemical Engineering Practice and took postgraduate courses at Columbia and at Johns Hopkins. He was married to Ann Reithel of Auburn, Mass. They had four children and five grandchildren. He was with the Worcester Gas Co., Baltimore Gas and Electric, and was a partner in Deks Chemical Co. of Baltimore. He belonged to the Engineers Club of Baltimore, was Vice President of the Baltimore Industrial Club, and a member of Richard C. Maclaurin Lodge for 50 years. For 44 years he was a member of Post No. 20 of the American Legion. He was a veteran of World War I. He passed away on November 4, 1977.

Our busy Secretary-Treasurer **Tom Rounds** and his wife, Marge, traveled to California to spend Christmas with their son, and went from there to La Jolla for a month's change and relaxation. Tom is one of the most energetic and dedicated members of our class. In his absence, I've been pinch-hitting for him.

Before I put down my pen, I'll seize this opportunity to thank those classmates who, unknown to me, have bought copies of my recent little book *The Vanderloon Twins* from Carlton Press, 84 Fifth Ave., New York, N.Y. 10011. It was fun to write, and I trust that some of my readers found fun and enjoyment in this autobiographical tale of youthful escapades.

I'm looking forward to seeing you in June. — **James A. (Pete) Pennypacker**, Assistant Secretary, Long Hill Rd., Essex, Conn. 06426

24

Your Co-secretary is contributing these notes, the occasion being that **Russ Ambach** lost his dear wife November 28, ten days prior to this writing. As many of our classmates know, Ethel had a long illness but was able, most of the time, to remain at home where Russ devotedly and tenderly took care of her with the help of nurses. Ethel was an educator by profession, her last engagement being at Milton Academy where she taught the first grade from 1955 until her retirement in 1967, and where she made many lasting innovations in elementary school methods. References to her life in the funeral service praised especially her selflessness and the spirit of cohesion she nurtured in the church women's activities. Russ flew with their son, Dwight, to Vienna where he is currently stationed, for a month of rest and recuperation with Dwight and his family. The

sympathy of the Class goes to them all, and to son Gordon and his family in Albany, N.Y.

Del Kendall is frequently seen by the Co-secretary throughout the summer. Del heads a group that plays on Lasell Junior College tennis courts at times when another group in which the writer plays is also out. Del's in a group of very experienced and meticulous enthusiasts, and Del's technique and physique show no signs of depreciation or obsolescence with age.

President **Frank Shaw** is planning a luncheon meeting of Class officers living within reach of Boston for some time in late January or early February. This will be the third or fourth such annual event, enjoyed by the wives, too.

From **Bill MacCallum**: "Eleanor and I are leaving November 8 for Los Angeles by car which we shall probably leave out there, and shall probably be back in Cotuit in early April. The Cape Cod Club has a fine start with lots of enthusiasm." . . . And from **Robert LeClercq**: "Still managing funds as investment counsel, but I'm semi-retired; I started a new career as an artist — water-color landscapes exhibited in five shows this year." . . . **Luis Ferre**, Chairman of the Council for the Arts at M.I.T., presented the Council's Eugene McDermott Award at the annual luncheon meeting November 2, to J.R. Killian, '26, Honorary Chairman of the M.I.T. Corporation. Former recipients of this distinguished award are Gyorgy Kepes, Klaus Liepmann, and classmate **Paul Tishman**. — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, Mass. 02146; **Herbert R. Stewart**, Co-secretary, 8 Pilgrim Rd., Waban, Mass. 02168

25

There is little news to report this month but it is all good. Your secretary attended the Alumni Council meeting in November and found our loyal triumverate of **Will Gardiner**, **Jim Howard**, and **Courtney Worthington** on hand. They miss but few of those meetings.

We have a most active retired men's club in Chatham and one of the regular attendees is **Will Mahoney**. This club meets every Friday, October through May, enjoys coffee and doughnuts, a sing-along, and a speaker. This year Will is on the coffee committee and he can be found in the kitchen before almost every meeting. My own contribution to the meetings has me playing the piano for the singing.

No direct word concerning **Ken Reynolds** has reached me for some time but I learn of some of his activities from his brother who lives in Chatham. He reports that Ken, who lives in California, has come east this last fall to visit Washington, D.C., and to do some cruising in Chesapeake Bay.

A note from **Frank Mulcahy** notes that he is a member of the M.I.T. Club of Boston and is a regular attendee at the meetings. He is feeling fine. . . . An early Christmas message from **Fred Greer** notes that he is well and settled in Naples, Fla., for the winter.

If you want more information in these notes let me hear from you. — **F. Leroy (Doc) Foster**, Secretary, 35 Woodland Way, P.O. Box 331, North Chatham, Mass. 02650

26

"Ike" Gleason, after a career with I.T.T. Corp. (when it was a telephone company and not a conglomerate), settled in North Carolina. His two sons live in the Northeast, so a couple of years ago, Ike and his wife resettled in Middlebury, Vt., where son Bob chairs the Chemistry Department. Ike has a history of being in the trouble spots of the world: with the Cuban Telephone Co. when Fidel took over and for a considerable time afterward, then to South Africa to study the possibility of taking over their telephone companies. Although that project did not work out Ike learned much about the relationship between the black and white populations. Ike also spent many Army years during World War II and in Korea, ending up as the Assistant Chief of Army Communications. Is it surprising that he has settled in Vermont? Always deeply appreciative of his M.I.T. training and education and the scholarship help that made it possible, Ike has designated an annual scholarship in his will for the most deserving VI-A student. When Ike told this to your secretary we asked his permission to include it in the notes because — as we justified our request — "it may put some ideas in the minds of other classmates." We think it a *great* idea.

George Breck, '26

Having reported **George Breck** among the obituaries about a year ago and receiving his reply that the "rumor was slightly exaggerated" a flow of correspondence started. I tried to run down the source of the story but the Alumni Office could not help me because George is still listed among their live ones. To prove it he has sent a recent photo in which he looks younger than in 1926. George and his wife are "birders" and were involved in the Christmas bird count at Ft. Lauderdale. Your secretary suggested some kind of celebration to mark his "resurrection." He takes a dim view of the idea and prefers to call it his revival. The thing that concerns him the most is that it took a year to get him back into the Class: consider it official as of January 1, 1978.

Argo Landau tells us that he and Edna are selling their large house in St. Louis and have bought a carefree condominium. They will be spending more time in Hawaii than during their last 19 visits and hope to catch up with **Bill Forrester**. We have asked for comments from classmates about their retirement locations to offset all the banter you have been forced to read about Pigeon Cove — which we will skip this month.

Dwight Woods has written from his base in Kerrville, Tex.: "I had two sailboats between 1960 and 1969. I never did race them as I did not like the dog-eat-dog competition. The *Thistle* was a most responsive boat but to sail it you and your crew had to be acrobats and my wife did not feel comfortable in it. The *Mobjack* was not so fast, but a lot more comfortable. My first sailboat was a cat-rigged centerboard 12-footer that father had built at Luders when he worked with Mr. Luders as a marine architect from 1914 to 1917. You may have your New England climate, but here at Kerrville our winters are mild and the summers not too hot. It was 34° this morning and at 2 p.m. it is 80°. This happens often. In summer the highs are between 90° and 95° with low humidity and a breeze. Water of any decent size is 100 to 250 miles away. You cannot have everything."

I will fess up to Dwight that for the first time we are wearing waffle underwear and with 35 m.p.h. northwest winds and 20°F temperatures they make walking with Heather tolerable. In her 13th year she still loves to prance in the snow. I enjoy a fire of well-aged logs on the hearth when we return from the walk — as we will shortly. — **George Warren Smith**, Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

27

The *New York Times* of November 16, 1977, reports an interview with two representatives of the firm Tippetts-Abbett-McCarthy-Stratton, designers and supervisors of construction for the Tarbela Dam in Pakistan, regarding the problems associated with its building. One of the two was **Johnnie Drisko**, and the *Times* describes him as "a staff consultant on hydraulics who took part in planning the dam. Earlier, Mr. Drisko was a technical aide to the International Bank for Reconstruction and Development (World Bank) during the steps leading to the 1960 treaty for a globally-sponsored multibillion-dollar program for dividing the waters of the Indus basin between India and Pakistan." What the *Times* doesn't make clear is that Johnnie's involvement has continued far beyond the planning stage, right up to the present. Tarbela has had, and still has, its problems but Johnnie told the *Times:* "You must keep it in perspective. Fifteen years from now, when Tarbela has been accepted by the irrigation fraternity and is grinding out the kilowatt-hours, the growing pains now won't mean that Tarbela isn't what it was intended to be, a successful project for storage, irrigation, and power."

Luke Bannon notes on the Alumni Fund envelope: "Being retired, and with failing eyesight, I am happy to be a homebody with my beloved spouse and to help out wherever I can when called upon. Probably my greatest disappointment was missing the Reunion, which I had looked forward to for many years." . . . **Larry Cheney** writes, "Visited my son in Lawrenceville, Ga. He lives across the street from the Ferrars, who said they were good friends of **Joe Burley**. Another case of "small world." . . . **Jim Flagg** confines his comment to, "Nothing new — still retired."

Here are a few more names of "missing" classmates. If anyone can supply information on their present whereabouts, your Secretary and the Alumni Office will be most grateful: **Richard P. Dixon, Robert K. Doten, Horace R. Dyson, William F. Fitzgerald**, Dr. **Gerard F. Flaherty, Florence B. Gregory, Cyrus A. W. Grierson, Harry H. Harris, Chia H. Huang**, and **Frank C. Hutchison**.

Your secretary has resumed daily commuting to New York City, briefly. Marion underwent surgery in the City early in December. She has been making a good recovery, and the doctor will permit us to fly down to Atlanta to spend Christmas with my daughter and her family.

We have lost two more members of the class. **R. Moen Smith** died on September 19, 1977, and **Joseph Wurtzel** died on September 21, 1977.

Moe Smith was one of my most faithful correspondents. He had worked many years for DuPont, and had held the positions of Works Engineer and Superintendant of the Tools Division before retiring in 1971. Since then, he had been living at St. Croix. After retirement, he did some consulting and managed a real estate office. His avocations included yachting and raising orchids. He was a member of the U.S. Power Squadron and an instructor in a course on seamanship, and he served on the Board of Directors of the Botanical Garden.

I have no recent word on Dr. Wurtzel. In the early 1940s, he took a degree in optometry at Columbia and later taught there and wrote a book on the subject. — **Joseph H. Melhado**, Secretary, 24 Rodney Rd., Scarsdale, N.Y. 10583

28

As the time approaches, it becomes increasingly evident that our 50th Class Reunion, June 6 to 11 at M.I.T., is going to be a tremendous party! As of this writing, 192 classmates and spouses have said they plan to come and 70 others hope to attend. Responses have come from all parts of the country and from abroad. Registration cards are being sent to those of you who have expressed an interest. If you are not one of these and may still want to attend, please write us a note (or a postcard) so that you, too, can be included. The obvious high level of enthusiasm has been most gratifying to your reunion committee and makes all of the preparation work well rewarded. It should be recognized here that Joe Martori's group in the Alumni Office is doing a magnificent job for us in performing all of the many reunion-related tasks such as typing, printing, and mailing of letters and forms to the Class; producing the

Class Directory; making reservations within and outside the Institute; arranging for meals on and off campus; and attending to no end of other details. We are, all of us, most grateful.

The several recent mailings to the Class have inspired a number of letter returns. One of these, from **Jack Rouleau**, has a special point of interest and, we think, should be presented as received: "Dear Walt, Your reference to the Senior M.I.T. jackets recalled an incident that took place when I was an assistant to Doc Rowe at Evans Memorial Research Laboratory on 80 East Concord Street (Boston). I cannot recollect the circumstances leading up to the matter of 'Cardinal Red' but, at any rate, Dr. Rowe went over to a safe in his office and carefully unwrapped a small package which contained two pieces of glass and a swatch of red cloth sandwiched between them. He explained that he had once decided that no one had really produced a 'Cardinal Red' at that time and had requested Cardinal O'Connell to provide him with a sample of real cardinal red material. This was the swatch he showed me. He continued that he had discussed the matter of dyes with Professor Samuel P. Mulliken who then devised a dye or dyes to match the Cardinal's swatch and that the dye was patented. Now I clearly remember Doc Rowe's facility with language, so perhaps there was a thought embellishment now and then during the telling. However, I hope my jacket meets the standard insisted upon by Dr. Rowe. Alice and I will be in Cambridge in June, 1978, *Deus voluit,* and are looking forward to this opportunity of meeting again with old friends."

In reply to Jack's comments and expressed hope: we have indeed given much thought and attention to the matter of color and shade for the blazer. Unfortunately, fabrics come ready-dyed so it is largely a problem of selecting from what is available. This we have done and hope that the committee's choice will meet with general approval. Of course, we cannot guarantee a precise match to Dr. Rowe's "standard" cardinal!

We have a few short notes to pass along: **Tom Harvey** wrote to ask for Ted Wood's address in Green Valley, Ariz. Tom and Gracia were planning a cruise on *Q.E.II* which was scheduled to terminate in Los Angeles after passage through the Panama Canal and wanted to contact Ted on their way home. . . . **Frank McGuane**, writing from Katonah, N.Y., lists his present activities as: Minister Prefect, Third Order of St. Francis; President, Katonah Village Seniors; Executive Board, Katonah Village Improvement Society; member, St. Mary's Parish Council; and choir. . . . **Tom Garrard** reports: "Retired January 15, 1977, and now busy with Oklahoma Medical Research Foundation and with local hospital."

We are very sorry to record the deaths of two classmates: **Thomas L. Reid** died September 30, 1974. The information was only recently received from his wife. Our records show that Tom was retired as Budget Director of the Massachusetts Department of Public Works and was a professional surveyor and engineer. **Ernest Santangini** died October 12, 1977, in Columbus, Ohio, where he was visiting his son Paul. Ernest was a graduate of Brown University and studied architecture at M.I.T. Most of his professional work was for the military services. Widowed, he is survived by his son and three grandchildren. To each of the families we extend our deepest sympathy. — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, Mass. 01890

Cambridge high school students who want to make their careers in transportation are now trooping to the Gustave M. Solomons Transportation Career Center. Mr. Solomons, who graduated from M.I.T. in 1928, expounded his enthusiasm for vocational education during several terms on the Cambridge School Committee between 1960 and 1970, and the new Center was named in his honor by a grateful Cambridge School Department last fall. With Mr. Solomons in the picture are Mrs. Solomons; Charles Evans, a Cambridge student using the Center; and a son, Professor Noel Solomons (right) of the M.I.T. Department of Nutrition and Food Science.

29

Charles B. Bacon has not yet retired and keeps a very busy schedule. He and his wife, Betty, are enjoying good health and are blessed with six children and 12 grandchildren. Three of their children live near their home in Middleton, Conn. Two of his sons are in the business, which must be a great help to him.

Salvador Madero, Jr., of Mexico is still in the manufacture of automotive parts and takes active part in the business even though he has just turned 69. His health is good and he enjoys meeting his fraternity (Phi Lambda Alpha) bro-

thers occasionally. "I visit the States two or three times a year, but haven't been in Boston since graduation. Though I took the Chemical Engineering Course, for over 30 years my work was in hydraulics, and for the past 17 years in top management. I expect to attend our 50th Reunion, if I am still around."

Rolf A. Zurwelle is still carrying on with his business, the Zurwelle Co., Engineering Consultant and Product Design. He also has a farm, which he is gradually converting to a horse farm, rebuilding stables, mending fences, etc. He also carries on some research in ordinance and solar energy. "I continue active in serving the Lord by teaching a high school Bible class. Most of all, thanks for the birthday greetings — and may yours also be a happy one when it comes."

Joaquin J. Llanso writes, "Having for years enjoyed reading the news of our Class it is high time that I contribute a bit by accounting for my activities in recent times. I joined the Worthington Pump and Machinery Corp. immediately after graduation and was with them for over 30 years, principally in their international business. During this time I was a resident for over 20 years in Argentina and Peru. I was also Manager of International Sales for a bit more than a decade. About 11 years ago I joined Knight Industries, Inc., formerly a packager of gas compressor units for Worthington in the petroleum industry. During the last nine years, however, our connections with Worthington were ended and we have since worked with the Superior Division, first of the White Motor Corp. and more recently of Cooper Energy Services. Almost four years ago I was elected President and Chief Executive Officer of Knight and besides managing the company I have continued promoting our international business, which has grown considerably in recent years — especially in South America. I probably shall end my active participation in the management of the company within the next year but health permitting I probably will continue as a consultant on a part-time basis for their international business. My wife, Dorothy, and I are enjoying our life in Tulsa and currently we have both our daughter, Virginia, and our oldest grandchild, Hope, students at Oklahoma State University in Stillwater. Our daughter, who obtained her B.A. degree from Vassar a number of years ago, is currently pursuing a doctorate in psychology. Our granddaughter is in her third undergraduate year."

A note from **Gus Stein** reads, "Thank you for the birthday card. When it did not come on time — as it usually does — I assumed that you had given us up, as an unrequited task. I am looking forward to seeing you after Christmas. I'm leaving day after tomorrow for Copenhagen to get a very dear friend out of the hospital, where she has been for two months after a bad auto accident. I hope to bring her back here to recuperate. Possibly you will meet her here when we get together."

Eric A. Bianchi also received birthday greetings and writes, "The card reached me at our new home (500 Ocean Dr., Apt. 5D-W, Juno Beach, Fla. 33408). We moved here mid-year, and Juno Beach is now our permanent home. We plan to spend part of the summer months in the North, but have not as yet selected a location. I have a small office in Tequesta, where I spend a few hours each week running Fluid Controls Institute (a trade association). I have been doing this since 1972 and find it helps me to get out of the apartment and maintain many of the business contacts I developed over the years."

Arnold W. Ewan, who attended our 40th Reunion and has the distinction of having traveled the longest distance — from West Germany — to attend, was in Portsmouth, N.H., last summer to visit his sister, Mrs. L. B. Lapham. Arnold is a retired Assistant Chief of the Power Procurement Division of the U.S. Army Area Command in Germany.

Anthony J. Perry writes, "Thank you for remembering me on my birthday. Sorry for taking so long to answer your note. I am now fully retired from the Corps of Engineers, except that I still represent a western engineering concern, which does not take too much of my time and gives me something to do. Hope to see you at the 50th Reunion."

Our glorious 50th Reunion is only 16 months away. Bring at least yourself, your wife, and another classmate. The place: Chatham Bars Inn on the Cape; the time: Monday, June 3, 1979, through Friday, June 8, 1979. — **Karnig S. Dinjian**, Secretary, 6000 N. Ocean Blvd., Apt. 14-E, Fort Lauderdale, Fla. 33308; (305) 946-0425

30

This month the available information is rather meager; only two relatively brief reports came in. **Charlie Gale** retired some years ago as manager of publications in the advertising department of Amoco Oil Co. He and Kathryn live in Oak Park, Ill., where he is a director of the Frank Lloyd Wright Home and Studio Foundation and of the Historical Society of Oak Park and River Forest. Charlie says he spends a considerable amount of his spare time in traveling by ship and reports that he has now covered the rather amazing total of somewhat more than 100,000 statute miles. **Henry (Hank) Halberg** has now retired from his job as a hydrologist employed in Little Rock by the U. S. Geological Survey, Water Resources Division. However, he has continued doing consulting work in his specialized field by working with citizens advisory committees and the Metropolitan Area Planning Agency in Little Rock on aater quality studies. He reports having recently seen **Hal Spaans**, as well as **john K. Vennard**'s widow Dorothy on the West Coast lst summer. . . . Regretfully the "obits" this month outnumber the returns from living classmates. A notice has just come in that **John "Pete" Lovejoy** died on June 8, 1976, but no details are available. My records show that prior to his retirement about three or four years ago he was president of Lovejoy Construction Co. in Des Moines, Iowa. Assuming that my 1973 information is correct, he is survived by his wife Pearl, two sons David and Roger, and three grandchildren. . . . A note from Virginia **Griffith** brings the sad tidings that **Arthur** died last August 11. According to my records, prior to retirement Arthur was assistant manager of district sales for Lukens Steel Co. in Schenectady. He retired in 1971, and he and Virginia moved to Summerville, S. C., where he reported "relaxing, golfing, gardening and enjoying becoming acquainted with historic and romantic Charleston and the plantations of the low country." There are two Griffith children; Virginia, who graduated from Smith and received a master's degree from Columbia, and Arthur, Jr., who graduated from Yale, studied law at N.Y.U. Law School, and is now a stockbroker. As of February, 1972, there was one grandchild. . . .We also have a notice that **Raymond Binder** died on September 18, 1977. Unfortunately, I do not have any information about him, other than the fact that he was a professor of mechanical engineering at U.S.C.

Presumably you have all received **Ralph Peters'** letter of October, 1977, reporting the status of our 50th year gift, and the fact that we still have a long way to go to achieve the $500,000 goal. As of the date these notes are being written, we are almost exactly mid-way between the 45th and 50th reunions and are still well short of 50 per cent of the goal. It seems probable that a substantial proportion of you have at one time or another participated in a fund-raising effort, and hence are familiar with the patterns of group giving, and in particular, the importance of the larger gifts which are often difficult to come by. In my own case I have found a reserved life income fund to be a useful way to achieve coincidentally retirement income and a significant gift to M.I.T. with favorable tax consequences. I suggest that if you are in a position to do something of this sort, and in particular if you are or have been self-employed, you might find it advantageous to explore this option. — **Gordon K. Lister**, Secretary, 530 Fifth Ave., New York, N. Y. 10036

31

A welcome letter from **Gardner (Skeex) Dean** is so interesting that I am quoting it in full: "I retired early (a little bit) in 1969 but have continued in the part-time consulting business ever since. This has worked out very well, leaving me a lot of time for various activities, but I don't get away for more than about a month at a time. We have done some traveling, but my principal activities have been with the Appalachian Mountain Club where I have held various offices in the local chapter. So Effie and I have done considerable hiking, skiing, and white water canoeing and some serious mountain climbing. These include Mt. Hood, Mt. St. Helens, the Grand Tetons, the Matterhorn, and several other 4,000-meter Swiss peaks. This year we have completed the Appalachian Trail, all 2,000-plus miles of it; this took about five years. And we have completed the 65 New England 4,000-foot mountains — this over a period of some 40 years. We were never very fast, but I don't believe we have slowed down much. We do enjoy the woods, and mountains, rivers, and snow.

"Our children are well and we have 4 grandchildren. I see my brother Walter ('29) from time to time — he lost his wife this summer. I have also seen **Arnold Childs** several times. He has a charming spot in New Hampshire just below Franconia Notch. We are still in Narberth. We like it here, so will probably stay put for a while longer."

Word from **John Hutchins** tells that he retired from the faculty of the Graduate School of Business and Public Administration of Cornell, where he was a professor, in 1975. John and his wife continue to live in Ithaca, go to Maine in the summer, and last winter, went around the world by ship. A recent note from the Alumni Association tells of the death of **John R. Vincent**, apparently sometime in 1975. Unfortunately, we have no further details. Our deepest sympathy to his family. — **Edwin S. Worden**, Secretary, Box 1241, Mount Dora, Fla. 32757; **John R. Swanton**, Assistant Secretary, 27 George St., Newton, Mass. 02158; and **Ben W. Steverman**, Assistant Secretary, 260 Morrison Dr., Pittsburgh, Penn. 15216

32

Another month has quickly rolled by. A few of our classmates have written, making it possible for me to assemble these notes. May I urge all of you reading this column to write anything about yourself, no matter how trivial you may think it is. We do like to hear about each other.

Nick Rothenthaler and his wife Marie are leading the good life in Largo, Fla. They came to the 45th Reunion in their motor home. Those of us that inspected the home were greatly impressed with its innovations, comfort and beauty. Nick is also adept at carving and polishing semi-precious stones and mounting them in a string or western-style tie.

Jim Harper reports that **Albert O'Neill** and **Al Dietz** have been busy with residential construction projects in the Middle East. Al has acquired a fairly good command of the Arabic language.

Mary Jones has written a letter to Ellie and **Ed Nealand** about how **Tom Jones** was so happy to have made the 45th Reunion and to see his classmates. Shortly after, the fungus galloped rapidly through his body and he died on July 29.

Ed and Eleanor have just returned from a trip to Hawaii. Incidentally, they stopped at Las Vegas and picked up $15 at Black Jack. Ed is now a director of a newly formed M.I.T. Club of Cape Cod. This promises to be an active group.

Donald Gilman writes how sorry Doris and he were to miss the 45th Reunion. At that moment they were busily engaged in helping a 55-year-old friend, who was marrying a foreign divorcee, in overcoming problems with the State Department and the Bishop. The Gilmans just returned from a trip to France, Spain, Majorca and the Canary Islands. The highlight was a dinner in Madrid with **Juan Serrallach** and Suzanne. They were both fine and they send their best regards to all our classmates. Juan in retirement, has apparently

enlarged the scope of his interests and investments and is more active than ever. Most of the evening was given over to reminicences, mostly Juan's.

Elton V. Buckley writes that he has been retired for four years and he has improved his golf game a great deal. He and his wife enjoy excellent health and do quite a bit of traveling up and down the east coast, depending upon the season.

Peg and **John Lyon** lead an active life of sports, travel, and work. They recently returned from a cruise in their sloop along the Chesapeake.

Peg sent me the obituary notice of our classmate and my college friend **Martin T. Meyer**. He was President of Theo Meyer, Inc., Pest Control, Philadelphia. He is survived by his wife, Norma, three sons and a daughter and four grandchildren.

We have also received the sad news that **William P. Cantono** died on June 28, 1977. — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, Mass. 01907

33

Fred Aldridge is Chief Sanitary Engineer for the Dade County, Fla., Department of Public Health. Fred was ready to leave Miami when the legislature passed the "Pure Drinking Water Act." The County found Fred the best qualified person available, so he took over serving 1.5 million residents plus the vast and unknown number of tourists that visit the area annually. He has agreed to stay one month or five years, and then he will take off for Chester, Mass., to become Town Engineer — at no pay. He gives us a list of chemicals used in his work, and the sources of contamination which make his job necessary. He intends to be in Chester this year for his high school's 75th annual reunion, so there is a real possibility that he will make the 45th at M.I.T. We have more than one Chester High grad in our class, but I can't remember who they are; maybe **Olavi Viita** is among them. **Werner Bachli** was born and raised out that way.

Stan Walters, 45th Publicity, is reviewing plans for the Reunion. And he sent a fine story on the Walters clan. Oldest son John is working for the Walters Company as a peddler, like his Pa, with headquarters in an old barn across the street from the house. Second son Tom is about to finish his work for a degree in music, and hopes to become a music teacher. When Stan wrote, Tom intended to be married last November. Janet graduated from Arcadia University, Nova Scotia, last June and is working on a master's at Wheelock College, Boston. Dorothy, good wife, is still active in volunteer hospital work, and starts a two-year stint as President of the Volunteer Program.

Raymond Brown, spent a coupla years in or near Paris for the Singer Co. The French were building a plant for the production of very small motors similar to those used by Singer. He and his wife, Jo, loved it. Now the Browns are retired and living on the Cape in Brewster, where Ray is a consultant in design and production of small electric motors to Molinex. Son Ronald is with American Express. Ray and Jo will attend the 45th.

Cal Mohr, writes that Susan Babcock, daughter of **Dave Babcock** of Rochester, N. Y., is now a freshman at M.I.T.

Bob White refuses to let retirement interfere with business: "Perhaps you knew of my retirement from the Torrington Co. in 1976. I was very happy in my old age until my old gang persuaded me to make a serious mistake. I have been back at work at Torrington since last May." The White's stay in Venice, Fla., for their winter vacation, and hope this year to make it down by the end of January. My son, Warren S., is still Senator from that district, though he is careful not to look up any of my classmates who are not voters in Sarasota County.

Now, just a bit for the 45th. You all know who the very competent committee is, and what they will do individually. I have a request to make of each of you to increase our attendance. Would everyone who expects to attend write me a short note, say who he would like to see, come June? Just give me two names, and I will write to both. For example, **Red Williams** might write to say that he would like to see **Walt Duncan** and **Tom Fitzpatrick** at the Reunion. I will then write to Walt and Tom. We might whack up 30 to 40 more people this way. And to repay me for the mention, I ask Red to send me the story of his family and job over 45 years.

President **Dayton H. Clewell** has appointed me Chairman of the Nominating Committee. I am very serious about electing one particular man Executive Vice President, though naturally I can't say who here, as the committee and **Ellis Littmann** will surely wish to have a hand in selecting his successor. I hope no one forgets that **Ed Goodridge** first suggested that we establish the office; how I miss that guy.

Ellis Littmann just sent me a full-page story from the *Post Dispatch* about the National Medal of Science awards. Among the 15 honored by President Carter is our own **Morris Cohen**. This is an important accolade, and Morris has been the recipient of many.

Christmas card from **Ellery Clark** tells us of more travels in his Airstream Trailer — to Utah, Montana, Idaho, Washington, and Oregon. He caught a silver salmon. The Clarks have a new grandson, Ryan David, the progeny of daughter Margie, who is a pre-school coordinator. Ryan's sister, Tania, is in kindergarden. Virginia works for Shreve's Jewelry, and son Steve for Honeywell. The Clarks will come east this summer and attend the 45th.

The Institute of Electrical and Electronics Engineers Inc., elected **Ivan A. Getting** its President. When Ivan wrote that he was retiring from Aerospace, he didn't even mention this honor.

Athelstan Spilhaus, one of our more distinguished classmates, spoke at the dedication of Northwestern University's new Seeley G. Mudd Library for Engineering and Science. Dr. Spilhaus' honors are so many as to preclude our covering them again.

We have several Alumni Fund capsules, always welcome. **Bob Heggie** is "still active in consulting and municipal affairs in Palm Beach." As always, **Frank Gilmore**, safely esconsed on Cape Cod, is doing church work as head of the long-range planning committee. He recently helped organize the Cape Cod M.I.T. Club and is its vice president. With the other hand, Frank indulges in a lot of boating, having cruised the Maine Coast, and explored the Intracoastal Waterway. . . . **Edward J. Malkin** is a transportation consultant in Chicago. . . . **Bill Sheppard** is Chairman of the Manasota Chapter of SCORE (an organization of retired executives).

There comes to us far too often a most distasteful horror story. This one concerns Mildred and **Chuck Thumm**. Ellis Littmann wrote December 1 that he visited the Thumms in Scotsdale, Ariz. Ellis and Roz thought both Thumms looked well and were quite enthusiastic about the coming 45th. On December 9, I received a letter from Westy with a copy of a story in the *New York Times* dated December 5 reporting the fatal shooting of both Charles and Mildred, and two ranch hands. The murderer is unknown, but a disgruntled employee is suspected. The Thumms owned the Cochise Lodge and Guest Ranch and are survived by two children, Janet and Bruce. — **Warren J. Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, N.H. 03833

34

Sorry to have missed last month's issue, but there wasn't much material on hand and I got caught up in other work. But this time there's a little more for us.

The October *Fortune* gave **Walter Bird** a nice plug in an article on "A New Air Age in Construction." Walter is the founder of Birdaire Structures in Buffalo, which has been a big factor in the growth of air-supported buildings. He developed the idea when he was at Cornell Aeronautical Laboratory in 1946. The article describes the ten-acre sheath on the Pontiac Stadium which makes it the largest air-suspended roof in the world. While it does not specifically ascribe this job to Walter's firm, it certainly is an outgrowth of his work. Definitely part of his work is the torus that surrounds the microwave installations on the C.N. tower in Toronto, some 1,100 ft. in the air. I'm sorry I didn't know about it when I visited the tower in October.

John Dunning sent some notes "if anyone is interested." Of course we are. He says, "I retired two years ago as a Vice President of the Bank of New York and find the leisurely life very pleasant. Tennis, paddle tennis, sailing, swimming, snorkeling, water skiing, house repairs, traveling, family interests — all consume my time. Fortunately, good health for me and my wife, Dorothy, still allows these things — in moderation. I am also learning to fly a light airplane — and even managed to solo a bit back. We have two sons, and five grandchildren, who have one grandfather, age 90, all living in our area, and a happy life."

Bits and pieces: I have been graced with an invitation to join the Alumni Council (people active one way or another who are within reasonable range of Cambridge). At the October meeting I saw **Hank Backenstoss** who is now living in Boston and doing individual consulting. At the November meeting I had a chance to see **Paul Wing** and Norm Krins. We now have quite an active club on Cape Cod and at a recent meeting **Ray Jewett** told me that **Mal Stevens** had undergone rather serious arterial surgery and was in Barrington, R.I.

I have two Alumni Fund notes, and as you read, you will see that the last part of the second one is personally very reassuring. **Bill Schumacher** notes, "I am now a first-time grandfather with the birth of Jennifer Ann to son Walter and his wife Valeria." . . . **W. Olmstead (Stead) Wright** says, "In August and September we completed a 7,200 mile driving trip through Quebec (Gaspe Peninsula), New Brunswick, Prince Edward Island, Nova Scotia, Maine, Cape Cod, Scarsdale, N.Y., Silver Spring, Md., and Hot Springs Village, Ark. I lost all my golf and bowling muscles. We dropped in on Jane and **Bob Franklin** in Brewster. They are looking great." Ah, to see ourselves as others see us! We welcomed the chance to see the Wrights and were able to lend them some books for some historical research they were doing.

I mentioned being in Toronto in October. This was after a visit to Ottawa based in equal parts on my wanting to visit a mini-convention of model railroaders who are interested in British prototypes, and a chance to see Mona and **Eric Isbister**. After his retirement in June from Sperry, Eric arranged to work as a consultant for Sperry Ottawa on radar project for ship control in the St. Lawrence River. They will be there for at least a year — and longer, if Sperry Ottawa lands the contract. — **Robert M. Franklin**, Secretary, 620 Satucket Rd. (P.O. Box 1147), Brewster, Mass. 02631; **George Bull**, Assistant Secretary, The Elizabeth, 4601 N. Park Ave., Apt. 711, Chevy Chase, Md. 20015

35

Bernie Nelson reports, "Few responses are coming in as to where we should hold our 45th Reunion. Most recently **Bob Olsen** and **Hal Everett** voted for the mountains. Last spring the few comments were split between the mountains and Cape Cod. Your Selection Committee is interested in your preference of location for reunion.

Rhoda and I were in New York just before Thanksgiving and had a wonderful evening with Jo and **Don Gittens**. We had just returned from a trip to Cairo, Abu Simbel, Aswan, and Luxor."

I'm sorry to report that **Charlie Goodale** died on December 15 at the Hyannis Hospital. I send my deepest sympathy to Ann and the family.

Dick Shaw sent me a clipping he found in his father's house following his father's death in October. The headline: M.I.T. Freshman Class Elects Officers. In case you had forgotten who they were: President, **Ned Collins**; Vice President, **Art Zich**; **Pete Grant**, Secretary; **Chet Bond**, Treasurer; **Hank King** and **John Hunt**, Institute Com-

mittee; and Dick Shaw and **John Tyler**, the Executive Committee. We appreciate his sharing this with us. Dick wishes he could swap his bowling and golf scores — Duck Pins in the bowling.

Hal Everett reports through the Alumni Fund Office: "I'm not retired yet, but possibly I will be next summer. Meantime, I'm getting more and more happily involved in my hobby of geneology — totally library research now, but I expect to tackle original sources later when I have more time. I'm finishing up an advanced course to qualify as a professional geneologist." Hal also reported that he was expecting to become a grandfather just before Christmas when a new citizen would arrive in Laconia, N.H.

Don't forget to report your location preference for our 45th to any member of the committee: **John Taplin**, **Rufus Applegarth**, **Vince Ulrich**, and **Pete Grant**. You can write to the committee in care of me and send news at the same time. — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

36

Herewith another installment from the mail bag. Just rereading the letters has given me much much enjoyment, and I hope I can share it adequately with all of you. There is absolutely no rhyme or reason to the order of presentation; it is strictly random.

Stanley Brown reports from Winnipeg, Manitoba, his home since 1971, that he plans to retire to Ajijic, Jalisco, Mexico. . . . **John Grindell** writes from Augusta, Georgia, that he is teaching mathematics at Phillips College. . . . **Pyam Williams** plans to retire from the Robertson Paper Box Co. in Montville, Conn., on April 1. The Williams will then move to Islesboro, Maine. . . . **George Crummey** retired last March and moved from Cleveland to Charlotte, N.C., where the latchstring is out at 41400 Knob Oak Ln. (28211).

Frank Parker reports from Boston that his "principal preoccupation these days is that of a fiduciary — concerned with other people and other people's money." He suggests that this is not very competitive but that it can lead to sleepless nights! . . . Another Florida-bound classmate is **Gerry Blackburn**, who five years ago retired from the Canadian public service to accept a post as Visiting Professor in the Faculty of Management Sciences at the University of Ottawa. He thoroughly enjoyed the teaching and consulting but has now "fully" retired. . . . **Gerry McMahon** writes from Lake Charles, La., that he plans to retire next September 1; the youngest of six children will graduate from college in May, just in time!

Not everyone is retiring — **Richmond Eddy** has recently opened an office in Jamaica, N.Y., after years as a registered architect in New Jersey. He is specializing in alterations to "problem" buildings — stores, apartments, and residences. . . . In addition to her teaching at Temple University, **Ruth Humphrey Perkins** takes ballroom dancing lessons, swims, walks, and goes to symphony concerts, ballet, and theater. She reports that these activities keep her out of mischief!

Al Bagnulo has given up after a third attempt at retiring and is back at work as a part-time employee of Greeley and Hansen, Engineers, involved in the development of a facilities plan for improvements to the City of Richmond waste water treatment plant. . . . "Thoroughly retired" is the way **Norman Cocke** describes himself. He prefers to stay put in Myrtle Beach, S.C. . . . Gadding about with a purpose is **Jack Ayer**, who retired three plus years ago from the Denver and Rio Grande Western Railroad. His home is in Denver, but he has spent several months in New Sharon, Maine, giving the old family farmhouse much T.L.C. He did take time off to visit with Dorothy and **John Easton** in Tenants Harbor, Maine.

Bob Gillette also seems busier than ever. He continues as Chairman of National Life of Vermont and also Chairman of the Executive Committee of Garden Way Manufacturing Co. which makes rotary tillers for gardens and other related items (including a garden cart your Secretary has been eyeing). He chaired a privately funded study of administrative costs in Vermont state government which seems to be resulting in substantial savings in the general fund budget. . . . **Henry Lippitt**, in his capacity as Executive Secretary of the California Gas Producers Association, continues to struggle with the California Public Utilities Commission and Governor Brown's administration.

Alan Brigham reported in October that he was convalescing well from surgery but not everyone is that fortunate. **Albert Emerson** was at that time confined to Pentucket Manor Chronic Hospital in Haverhill, Mass., after having suffered a stroke which left him paralyzed on one side. By the time you read this we can hope that he is much improved.

Last fall I reported that **Henry McGrath** had been honored as a Pioneer by The American Institute of Chemists and now across my desk has come the May, 1977, issue of *The Chemist* with pictures and an article based on his acceptance address entitled "Coal to Gasoline and Gas." It is described as a "provocative presentation" and I recommend your reading it. — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, Conn. 06091

37

George Levy remarks that "much water has run under the bridge since I last wrote wrote" (he's right) and goes on to report that "Barbara has come into the family business as Executive Vice President and handles all the gourmet houseware and boutique gift buying and merchandising. She is doing a great job. Janie, my oldest, Mrs. James Lawson Reed III, has blessed us with a handsome baby boy, James Lawson Levy Reed. Nancy, the youngest — Nancy Ruth Levy — is working on her doctorate at Boston College and should complete it by April while teaching several Spanish courses at Boston College and Wellesley. As for me, I keep active in local politics, on the Board of the Chamber of Commerce and the Temple, President of the Newton Center Improvement Association, active in the M.I.T. Club of Boston — West, etc. We are all in good health and look forward to the 45th reunion." **Robert E. Hopkins**, Professor of Optics at the University of Rochester's College of Engineering and Applied Science, has been named to receive the Society of the Photo-Optical Instrumentation Engineers' Alan Gordon Memorial Award for 1977. **Frank Lewis**, who says he is semi-retired, is now Chief Engineer of a new company, Caywood Electronics, Inc. in Malden, making the radio armature equipment line from the James Millen Manufacturing Co., (which closed up on May 31, 1977).

It is with deep regret that we report the death of **Walter Sherry** on October 15, 1977. Our sympathy goes to his wife, Joan, and his family. — **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Lester Klashman**, Assistant Secretary, 198 Maple St., Malden, Mass. 02148

38

By now I'm sure you all have scheduled your attendance at our 40th reunion in June. Plans are shaping up, and all of us young old people will have an opportunity to renew old friendships and to see the changes (for the better) at Tech.

Ed Hadley wants me to remind you that the deadline is fast approaching for the reunion book. Send photographs, filled-out questionnaires, and 150-word autobiographies to G.E. Hadley, 50 Spofford Rd., Boxford, Mass. 01921. If you have mislaid the questionnaires, ask him for extra copies. Jean and Ed Hadley got tired of working on the reunion book in December and decided to spend three weeks in the Orient, visiting Tokyo, Bali, Singapore, Bangkok, and Hong Kong. Stay tuned for a thrilling account of what and whom they saw on the trip the next issue.

Your secretary just returned (at date of writing) from several weeks in the U.S. Virgin Islands, snorkeling and basking in the sunshine. The problem is the readjustment to the realities of cold New York!

We just learned that Col. **Henry Thayer** passed away in October. He had been living in Silver Spring, Md. — **A.L. Bruneau, Jr.**, Secretary, Hurdman and Cranstoun, 140 Broadway, New York, N.Y. 10005

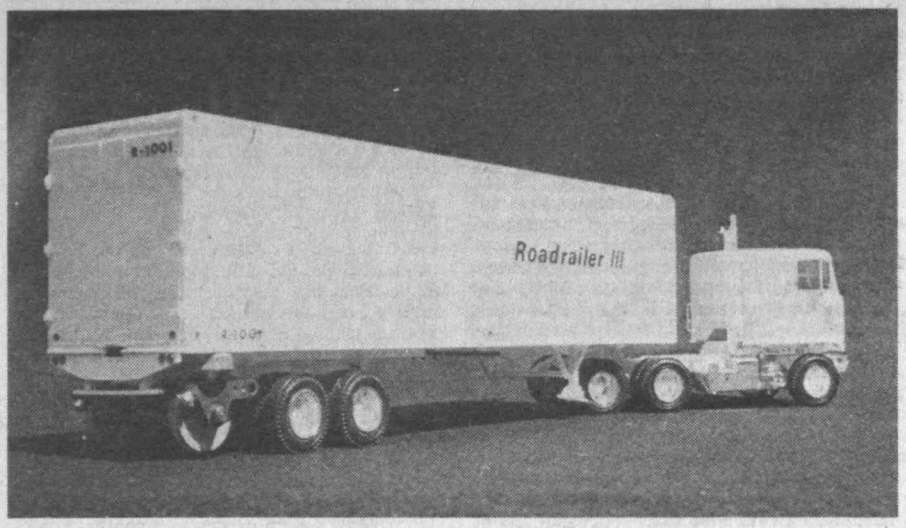
40

Kudos: **Stewart E. Miller** received the Franklin Institute's Stuart Ballantine Medal at that institute's annual Medal Day last November. Miller directed the Bell Lab group which did much of the original research leading to the development of lightwave fiber cables communications systems. A fraction of the size of copper wire cables, lightguide cables are compact and immune from electrical interference. This medal is the latest of many merit awards Stewart Miller has received, among them the Liebmann Award (1972) and the Baker Award (1975) from the I.E.E.E.

Major General (ret.) **Robert F. Seedlock**, project manager for the design and construction of what will be one of the world's largest airport complexes in Jeddah, Saudi Arabia, was made an Honorary Member of the American Society of Civil Engineers at the A.S.C.E.'s 125th annual convention. The project is a joint venture of Ralph M. Parsons and Daniel International. Major Seedlock retired from his army career in 1968 and has gone from one huge project to another, including rapid transit programs for Atlanta, Ga., and Allegheny County, Penn. He is also nationally prominent in the Boy Scouts of America organization.
In The Thereafter: Our retirement department continues apace. **Joseph K. Knight** writes, "After over 37 years with DuPont, I have decided to retire in January, 1978. I hope to keep out of trouble by undertaking some community volunteer work as well as a more serious pursuit, restoring antique furniture. I plan to stas on in my bachelor home in Concord, Calif." Concord is an easy commute via Bay Area Rapid Transit from San Francisco. . . . Terse and to the point, **George Kaneb** says, "Still active in tennis, hunting, and fishing."
Deceased: **Lawrence D. Phillips** of Saugus, Mass. We have no details of his death.
Along the Potomac: **Al Guttag**, our Secretary Emeritus, this year tallies 35 years in patent law in Washington, D.C. After 11 years in the U.S. Patent Office, he has been for 24 years with Cushman, Darby and Cushman in the District. But "after hours" it is another matter. Al writes, "I went back to running a number of years ago and now run regularly 5 to 20 miles a day, usually 6 to 10 miles." As a member of the Potomac Valley Seniors Track Club, he has set a record for the ten-mile run for a 57-year-old. "With good luck that record will stand for all time if the United States goes metric in a hurry." It isn't all patents and Adidas, however. This past summer Al, his wife, Norma, and their two younger boys took a 17-day trip to Europe. The high spots were Frankfurt, Hamburg, Munich, Vienna and Salzburg.
The Happening: A new department is established to receive comments about details of location and activities for the 40th Reunion of the Class of 1940. From last month's invitation for comments, **Al Guttag** speaks his mind: "A number of people at the 35th indicated they wanted to have the reunion away from Tech. I would suggest that a poll be taken even though there is pressure from the Institute that it be held on campus. I know of a number of classmates, myself included, who probably will not attend if it is on campus." Al has sent his message. And your opinions and suggestions? If you feel a poll is in order, what would you ask your classmates? — **Frank A. Yett**, Secretary, 1405 Ptarmigan Dr., Walnut Creek, Calif. 94595

41

Larry Turnock, who visits Pittsburgh often, sent an American Society of Mechanical Engineers



Robert S. Reebie, '43, is now busy planning and promoting this "Mark III Road-Railer," a self contained unit interchangeable between highway (as a semi-trailer, shown) and rail (as an articulated boxcar) operation. He says "Road-Railer" intercity transportation costs will be 44 per cent below those of all-highway transportation and 24 per cent below those of conventional "piggy-back" trailers-on-flat-cars, and he speaks of "dramatic improvements in service quality and reduced costs" for railroads using them.

"Road-Railer": From Highway to Railway in One Easy Step

"Piggy-back" rail freight service — semi-trailer units carried in intercity freight on special flat cars — is now obsolete, says Robert S. Reebie, '43, President of Bi-Modal Corp.

The new look is Mr. Reebie's "bi-modal Road-Railers," self-contained units which operate as semi-trailers with highway wheels extended and as articulated boxcars with rail wheels in place. They're a new adaptation of a concept pioneered in 1959 by the Chesapeake and Ohio Railroad on its Pere Marquette District in Michigan; the original C and O program was the responsibility of Kenneth A. Browne, who is now one of Mr. Reebie's partners in the Bi-Modal Corp., formed early this year to design, build, and promote the new "Road-Railers."

Substantial savings in time and money are promised by Mr. Reebie for the new equipment:

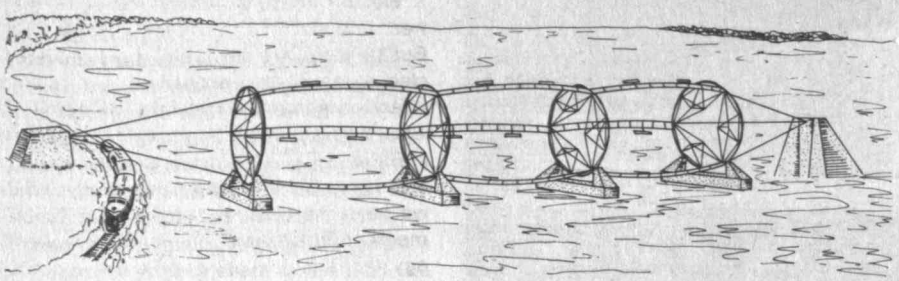
—Because "Road-Railers" are self-contained, they eliminate the need for flat cars; they thus save 30 per cent of the weight of "piggy-back" systems.

—Investments in "bi-modal" freight equipment will be 28 per cent lower than that required for equivalent capacity in "piggy-back" cars and trailers.

—"Road-Railers" are "merely rolled in or out of trains," says Mr. Reebie, eliminating the need for special equipment at terminals. As a result, terminals will require 29 per cent less investment and incur 20 per cent less operating cost than those now devoted to "piggy-back" operations.

—Trailers in "piggy-back" service are limited to 12 feet 6 inches in height and 40 feet in length by railroad clearances; terminals on Manhattan, for example, are thus foreclosed to them. But "Road-Railers" on their own wheels will be governed only by highway size limits — 13 feet 6 inches high, 45 feet long — and can be hauled anywhere on standard-gauge rail systems in the U.S.

The first prototype "Road-Railer" vans are now being made, and Mr. Reebie says they will be in operation before the end of next year. There will also be 20-, 27-, and 40-foot units for shipborne containers and specialized refrigerator, hopper, and tank units.



Wind Into Electricity on a Large Scale

When David Z. Bailey, '44, turns to wind and ocean energy, the scale of his innovation is large indeed. Consider a system of cables stretched across a river between two anchorages 100 meters apart, carrying rotors which spin in the current. Or a structure 50 kilometers long submerged in the sea off Nantucket bearing rotors to convert the Gulf Stream into electricity.

The common denominator of these proposals is the idea that the diffuse energy in wind and water can be collected and extracted in usable quantities by rotors mounted on large units whose stability is assured by members in tension rather than in compression.

Using this concept, Mr. Bailey proposes that power levels in excess of 10,000 megawatts can be generated by a floating wind system (*see above*) or by the submerged system off the U.S. Atlantic Coast. The cables to carry these systems are about the size of those used in large suspension bridges — "easily within the scope of existing technology," says Mr. Bailey.

profile which quotes in detail **Rogers Finch**, Executive Director and Secretary.

Allan Firmage, a Civil Engineering Professor at Brigham Young University, has been elected International Contact Director of the American Society of Civil Engineers (A.S.C.E.). Allan has taught at the University of Florida and Guindy College in Madras, India. He has been President of the A.S.C.E. Utah section and is a consultant on bridge design to T.Y. Lin International.

Massachusetts Governor Michael Dukakis and **Joseph Gavin, Jr.**, President of Grumman Corp., announced the move of CallData Systems, Inc. from Long Island to Newton, Mass. CallData has $12 million in sales and will invest $10 million in computer and data processing equipment. Grumman, the parent company, has sales of over $1 billion and was the prime contractor for the lunar landing module.

Reid Weedon has been named the 1977 recipient of M.I.T.'s Dalton Bowl in recognition of conspicuous and sustained service to M.I.T. Reid is Senior Vice President of Arthur D. Little in Cambridge, Mass. — **Henry Avery**, Secretary, U.S.S. Chemicals, 2863-600 Grant St., Pittsburgh, Penn. 15230

42

George Toumanoff has been appointed Vice President of Cutler-Hammer's Transportation Systems Division in Deer Park, N.Y. . . . **Bob Rines**, our one and only law school president, spoke at the November meeting of the Engineering in Medicine and Biology Group on the truly formidable subject of "National-International Trends in Patents and Technology Transfer."

El Heraldo newspaper in Mexico announced the death of **Erwin Anisz** of Course X, on October 26. Quite a few of us will remember "Mex" zipping around Cambridge in his sporty Buick convertible. He was a warm and delightful friend and will be missed. Our sympathies to Eva and to his son, Joseph.

That runs us out of news which is a very scarce commodity this month. Fortunately, we still have a few mini-biogs to run, so here they are: **Lou Rosenblum** is our Northeast Regional Vice President. He and Sandy live in Belmont. Lou has been one of our most active alumni workers. I really do not recall any important Alumni Association committee on which Lou has not served at one time or another. In his spare time Lou operates a consulting firm specializing in computer processing, graphics and optics. Sandy teaches piano and does research in and editing of early musical manuscripts. Laurie is 21, just back from an extended sojourn at the University of Edinburgh; Bruce is 18 and a freshman at the University of Pennsylvania. I recently saw some of his photographic work. Bruce has inherited Lou's interest and expertise in photography.

Hugh Schwarz received his S.M. in Course X-A but was not with our class as an undergraduate. Hugh was originally in the orange juice business; that company was purchased by Coca Cola and Hugh is currently Vice President for Planning at Coca Cola's corporate headquarters in Atlanta. There is a myth that graduate students are not active in alumni affairs. Hugh is the exception proving the rule. He has been a dedicated worker in the Southeast and also in Cambridge. His services earned him one of the first Bronze Beavers awarded to a member of our class.

Last on the roster is yours truly, our secretary, **Ken Rosett**. My wife Jean, Som Phong the Siamese cat, and I live at the address listed below. Nancy is 31, lives in Norwalk, Conn., and teaches math at Wilton High School. John is 26 and works for a wholesale photo supply house in Chicago. With United Merchants and Manufactures swinging between Chapter XI and Chapter X, I've left my position as Vice President and Marketing Manager of its Uniglass Division. Recently formed KEN ROSETT/Associates, a consulting firm to the industrial fabric industry. Thus far it is interesting and rewarding. (Translation into English: I've got some paying assignments.) I'll be glad to send my brochure to anyone who is interested and/or

who'll send me some of the aforementioned scarce commodity — Class News. — **Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, N.Y. 10605

44

Instead of a scattering at several tables, we filled Dining Room 3 at the Faculty Club on December 9. "We" means, in this case: **John Hull**, **Andrew Corry**, **Robert Horn**, Ruth and **Norman Sebell**, Edna and **Stan Warshaw**, Doris and **Chet Woodworth**, Marguerite and **Ed Ahlberg**, Anita and **Leslie Brindis**, Priscilla and **Bob Breck**, Joan and **Allan Porson**, and **Melissa** and **Newton Teixeira**. It was a gathering that turned out to be the organizational meeting of the "Class of 1944 Reunion Committee," duly appointed by **John Hull**, Class President, but — and very important — still open to interested alumni. The dinner meeting was thereby transformed into a decision meeting. (As reported in the last issue of these notes, the Sebells had done a great deal of the ground work and were the official organizers.)

Many alternate locations were discussed for the 35th in 1979. To maximize participation and permit optimal stopovers at the Institute, it was decided to repeat the outstanding success of the 30th, in Bermuda. But the idea of the Sebells' for a 34th in 1978 had caught on. Since this would be a regathering of classmates, not linked to any particular Institute schedule, we will have much more flexibility. It was pointed out that the airline fare in the package now predominates over hotel bills, quite different from 1974. However, Edna Warshaw lit a candle of hope. She knows someone who has been able to put together tours or charter packages, large or small, at what appear to be substantial reductions. This information lifted our horizons.

Elvira and **Arturo Morales**, who have made the long trip from their home in Mexico City many times (including the 30th trip to Bermuda) have often offered to assist in arrangements for a class reunion there. Everyone on the committee, with kind thoughts for the Morales, desired to notify them with the hope they might have specific suggestions that would help in our next meeting, at the Warshaws' house on January 13.

Since we now have a committee large enough to make up a respectabe reunion group all by itself, we feel confident as we enter the new year.

From Buffalo, a new division of Worthington Compressors is headed by **Robert A. Metzger** as President.

Flap Facts: **John H. Burdakin** of Michigan is President of Grand Trunk Corp. (Canadian Nationals' American interests) and President of three railroads. He's on Governor Milliken's Job Development Authority. John has been in railroads since he graduated in Course I. Now the last of his three sons is at Michigan State, his second is a 1977 Lehigh graduate with American Can in New York State, and the oldest is in his last year at Wayne State Medical School. (How's that for getting everyone off on the right track?)

Mary E. Guinan writes that she is "still quietly proving that an M.I.T. woman can find a successful and challenging career as a writer of architectural specifications and advisor on materials. My young colleagues never seem to question that 'Mother Knows Best.' "

Will B. Rodemann sent us a personal note and we thank him right back. Note of Interest: To those who have access to the I.E.E.E. *Spectrum* for October, 1977, on page 52 in the article on Project Whirlwind is a photo of the staff and there, big as life, at the end of the right hand table is **Harry Kenosian**. At the other table, I think (with much less assurance) is **Eugene Sard**. Maybe one of these two classmates will enlighten us on the date of the picture, other classmates who might also be there, etc.

In August, 1977 **Arthur D. Saul, Jr.**, Civil Engineering, died. In October, 1976, **Robert D. Remington** died and in October, 1977, **Kenneth W. Joseph** died. Both were from Course II.

In December, a very special lady passed away: Catherine Clarke, wife of Bruce A. Clarke (Class of 1916), mother of **Robert I. Clarke** (Class of 1944). The young war bride Bruce brought back from the Pyrennes after World War I turned out to be very special to her son's classmates too. — **Melissa** and **Newton Teixeira**, Secretaries, 92 Webster Park, West Newton, Mass. 02165

47

The National Research Council's Committee on the Safety of Dams, chaired by **Harl Aldrich**, has issued a report about the Bureau of Reclamation's program for ensuring the safety of dams in operation. Overall the committee thought the safety program to be good, but it is recommending two things: that the scattered responsibilities for safety be centralized in an independent safety office, and that the emergency preparedness program be brought up to suitable standards. They also point to inadequate funding of some parts of the safety program, such as examination of dams for potential structural problems, landslide surveillance, and the monitoring of the safety of non-Bureau dams which might endanger Bureau dams which are downstream from them. They suggest legislation to make this last suggestion possible. Other M.I.T. people on the committee are Frank E. Perkins, '55, and Erik Vanmarcke, Ph.D. '70.

A bit about **John Karmazin**, our Vice President in charge of the entire Midwest. After graduation, John and his father founded Karmazin Products Corporation, which makes "the toughest oil coolers under the sun" (according to their postage meter). These are part of a line of air-cooled oil coolers and other steel heat exchangers. John is currently Chairman of the Board and President of the organization. Other interests include wife, Sandra Kay, and daughters Anne Marie, 12, and Julie Kay, 9, and memberships on the Boards of Directors of the Wyandotte Savings Bank, the Detroit Symphony Orchestra, and the Southern Wasne County Chamber of Commerce. John and Henry Ford II were the Vice Chairmen of the 1977 National U.N. Day Committee. He also belongs to an Athletic Club, a Golf and Country Club, and an Economic Club, the latter to keep ahead in financing the former, perhaps.

To their mutual good fortune, Karmazin Products has a new member of their Board of Directors: Wilfred D. MacDonnell, Class of '34, not a classmate perhaps, but a loyal and hard-working alumnus nevertheless, a member of the M.I.T. Corporation, and well-known for his other Institute alumni activities.

Here's a flash dated October, sent to me in December just in time for the February notes: **Bob Hagopian** is now the Director of Corporate Relations at M.I.T. He "will have major responsibility for directing and implementing programs of the National Business Committee organized in support of M.I.T.'s on-going $225 million Leadership Campaign. The National Business Committee, composed of about 50 leading corporate executives, was formed last year as a means of strengthening and expanding M.I.T.'s interaction with industry." Dr. (former Dean) Irwin Sizer will coordinate the internal operations of the committee at M.I.T., in association with Bob, and with the help of Professor Emeritus J. Francis Reintjes. Bob will also be maintaining close ties with two organizations that promote close communication with industry on current research efforts, M.I.T.'s Associates Program, and the Industrial Liaison Program which he helped build to a membership of 159 companies when he was Institute Secretary for the ILP. After receiving his M.A. from New York University's Center for Safety, Bob worked for a number of years as Director of Industrial Safety for what is now the American Insurance Association. Ten years ago he returned to the Institute as Associate Director of the Alumni Fund, "responsible for all geographic programs worldwide." He became Institute Secretary in 1973.

From the *Boston Sunday Globe* about **Parker Symmes**' company: "Cambridge architects Symmes, Maini, & McKee, with two years of planning input by WBZ-TV news executives and staff to go by, have designed a 9,000-square-foot, one-

The Holistic View of Infratechnology

Science and engineering . . . research and development.

We use these combinations as if they were one word, representing a single idea. But the ideas are disparate, the distinctions clear and clearly practiced.

And herein lies the root of some of America's economic malaise, says Jordan J. Baruch, '47, Assistant Secretary of Commerce for Science and Technology. What we need, he says, is to emphasize fundamental and applied, science and technology, research and development all together as "infratechnology," and so take a dramatic new approach to creating innovative, modern goods and services.

Consider the shirt you're wearing; it is fashioned laboriously out of flat cloth to fit the human form — which is anything but flat; and it was probably made in southeast Asia because the labor to make it in the U.S. is too expensive. Perhaps it's time to step back from the sequence of spinning-weaving-sewing to seek "a totally new way of creating and decorating fibers in a three-dimensional shell of a finished garment."

That's an example of the innovative thinking that our compartmentalized view of science, engineering, research and development does not foster. Chemical companies and spinners make threads, fabric companies weave cloth, and designers, cutters, and stitchers turn the cloth into clothes. Who among them has the incentive and capital to tackle "the infratechnology of garment forming?" asks Dr. Baruch.

"The potential supporters of an infratechnology are too disaggregated to support it effectively; its potential practitioners are scattered among institutions with generally low collaborative potential. It is a classical example of a form of organizational market failure generally ignored by economists. Yet it is just the sort of market failure that prevents Adam Smith's free market from creating major technological innovation," Dr. Baruch told the colloquium on Research and Development in the Federal Budget sponsored early last summer by the American Association for the Advancement of Science.

He proposed that the creation of new infratechnology should be "the next creative step in providing national support" for technology. It's time, he said, for government" to foster the institution building and provide the aggregating support that will lead our creative minds to build these new infratechnologies on which our country . . . can build a major aspect of its future." — *J.M.*

story newsroom addition to WBZ-TV facilities on Soldiers Field Rd., Brighton, which now houses more than 70 members of the station's Eyewitness News team. Facilities to process all video news for the station's 47 separate weekly news programs, making the addition a self-contained unit, have been incorporated into the design, said Jon McKee, architect in charge, and TV news director Bill Alber."

Jordan Baruch, in an engaging and provocative article in View from the Top in the October, 1977, issue of *CHEMTECH,* defines and discusses "Infratechnology," an area of innovation which would bring together current technologies to produce new answers to some of the difficult questions some of our industries face. Read it. It's from a presentation before the American Association for the Advancement of Science, Colloquium on Research and Developement in the Federal Budget, June, 1977. Jordan is Assistant Secretary of Commerce for Science and Technology.

Someone else to visit in Washington is **R. Blount**, Deputy Director, Research, Development, Test and Evaluation, Office of the Chief of Naval Operations, at the Pentagon. Better phone first, though; he's so busy he says he doesn't have time to read his *Technology Review.*

John Yocom is Vice President and Chief Engineer for TRC — The Research Corporation of New England located in Connecticut. He has been with them since 1965, coming back to New England by way of Ohio and California. John and Elizabeth have a daughter, Judith Huling, and a 3-year old grandson Christopher, who live in St. Johnsbury, Vt., where Judith's husband is a builder and developer of energy conserving building systems. John is also interested in house construction and is building a Vermont hideaway. His energy conserving system, however, is Elizabeth, who, he says, picks up after him and his hobbies. Elizabeth teaches nursery school, enjoys ski-touring and belongs to a musical club. Both sing in the choir. John also builds harpsichords and plays them, and has taken up hunting, in conjunction with his gardening, which seems to be threatened by moles and ground hogs. (*Ground hogs?*)

Fortunately **Lew Bernheim** likes to travel. He writes: "Went to work with Beryllium Corporation in Reading, Penn. and had to leave after a year because I contracted Beryllium poisoning. On recovery went with Stauffer Chemical Company and toured all the states east of the Mississippi — then on to Bechtel Corporation with stints in The Hague, Holland, and London for a year. Returned to the states and changed jobs." He is currently Project Engineering Manager at C.E. Lummus, and lives in Short Hills, N.J. Since they returned from overseas, Claire has been involved in home and gardening, antiques and art, but she is contemplating going back into the insurance brokerage field where she spent 25 years insuring the airlines. Lew is rebuilding an old house, even as I. How's your caulking technique, Lew?

As we know; in the undergraduate sector, our class has one of the most diversified of backgrounds. There is a small group that started with the Class of '47 and finished therewith; there are those who started with earlier classes and finished in '47; and some started at other schools, came to M.I.T. in the service, and returned here after the war.

Fred Jenkins is in the last group; he started in Chemical Engineering at Northeastern University in 1939, came to M.I.T. in 1942 as an Army Aviation Cadet, and returned in 1946 to complete his degree. Since graduation, except for a flyer in Ft. Worth with American Airlines, he has stayed in the north and is currently living in Ann Arbor, Mich., where he is U.S. IFYGL Coordinator, Great Lakes Environmental Research Lab, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. In 1954 he received his M.S. in Meteorology from M.I.T. Fred and Aliss have two daughters, Karen, 28, and Susan, 22. Their hobbies make them sound terribly independent: while Fred is singing, sailing, playing tennis, and participating in theatricals, Aliss is swimming, gardening, bicycling, antiquing, and doing needlepoint.

Another sailor and navigator is **Fred Veith**, Old Greenwich, Conn. He has been with Pfizer, Inc., and Pfizer International since graduation and is now Vice President — Manufacturing and a member of the Board of Directors. He and Cornelia have lived abroad in England, France, and Brazil. They have three children, Hedwig, 27, Pamela, 23, and Craig, 17. Fred is a Fellow of the American Institute of Chemists. Cornelia does volunteer work at a local home for the aged and with the Red Cross Bloodmobile, and is Past Chairman of the Women's Fellowship at their church.

So where have *you* spent the last 30 years? Some of you haven't checked in since that fateful day in Symphony Hall. It's time to call home, classmates. — **Ginny Grammer**, Secretary, 62 Sullivan St., Charlestown, Mass. 02129

49

Belatedly we have learned that **Arthur R. Havener, Jr.**, an alumnus of Course X, Chemical Engineering, and a resident of Wayland, Mass., died in December, 1976. I have no further information.

Ralph C. Olsen is located in Denver, a Division Engineer in the Rocky Mountain Division of Chevron. . . . **Alex D'Arbeloff** is President and Chairman of Teradyne, which he co-founded with Nick DeWolf, in 1948. A recent *Boston Globe* article reports that Teradyne, with 1,400 employees and annual sales approximating $60 million, is the world's largest company specializing in the design and manufacture of automatic test equipment for the electronics industry and for many other industries using electronic devices.

Ira Dyer, head of the M.I.T. Department of Ocean Engineering, is Chief Scientist for CANBARX, a Canada Basin Acoustics Reverberation Experiment. A team of 12 scientists and their support staff will locate a camp on the ice over the Canada Basin several hundred miles north of the North Slope in the spring of 1978 (probably in mid-March) with the support of the Naval Arctic Research Laboratory in Barrow, Alaska. The month-long research program, sponsored by the Office of Naval Research, is aimed at gaining a better understanding of the nature of acoustic signals reflected and scattered from the distant boundaries of the basin. It sounds like a fascinating experiment, but after surviving the recent December cold snap, I'm not sure that I'd look forward with much relish to a month in the Arctic.

Eugene B. Skolnikoff, Director of the Center for International Studies at M.I.T., has been appointed as one of two Senior Consultants to Frank Press, Director of the Office of Science and Technology Policy, and Science and Technology Advisor to the President. . . . **Fletcher Eaton** has written a piece on "The Public Responsibility of Engineers" as the President's message for the Engineering Societies of New England. ahat the proper roles are for scientists in our legislative processes is indeed a knotty problem. . . . **Peter K. Stein** announces the 17th year of Measurement Systems Short Courses in Phoenix, Arix. in the latter part of March, 1978. Peter's Unified Approach to the Engineering of Measurements successfully marches on and on.

Carl A. Bergmann has left American Optical Company where he worked for 18 sears, most recently as President and General Manager of the American Optical Canadian Operations. He has been appointed Vice President of Worldwide Ophthalmic Products at Buckbee-Mears Company of St. Paul, Minn. . . . **John B. Donner** continues as Vice President and General Manager of the Federal Systems Division of General Telephone and Electronics Corp. In addition, he will be Vice President-Program Implementation and Systems Integration for G.T.E. Information Systems Incorporated, a subsidiary. Since one organization is in Anaheim, Calif., and the other in Silver Springs, Md., John will no doubt be expert in coast to coast air travel, if he is not already.

Last November, **Angelo R. Arena** joined Marshall Field & Company as President and Chief Operating Officer of the corporation. Angie has had a long and distinguished career in retailing, since he received his master of science and business administration degree from Columbia University in 1951. Starting at Abraham & Straus, he became a buyer at The Broadway in 1956. From 1965 to 1973 he was with Bullock's, decoming Vice President and General Merchandise Manager. He was Executive Vice President, merchandising and sales promotion, at Weinstock's. He was then President of The Emporium, and finally, Chairman of the Board and Chief Executive Officer of Nieman-Marcus.

A final note of recognition for a distinguished classmate. **Charles K. Holmes, Jr.**, was awarded the 1977 Bronze Beaver. His testimonial reads, "An outstanding alumni leader in many communities, including San Francisco, Dallas, Atlanta, and Concord, Mass. Chuck has served the Association by bringing his enthusiasm and vision to the planning and implementation of many programs on the local and national level." Congratulations. Best wishes to all. — **Frank T. Hulswit**, Secretary, 77 Temple Rd., Concord, Mass. 01742

52

The news so far this year has been very sparse. Finally enough items have been assembled to constitute a reasonable column. Please, if you have news of yourself or any classmates, write to your secretary or assistant secretary.

The past secretary, **Dana Ferguson**, writes from India that he is on a trip through South India and Sri Lanka. He notes that on this trip he finds India is growing rapidly modern and he is enjoying himself very much. . . . Travel, of a more local nature has brought **Douglas F. G. Haven** to a new address at Point Hill, West Barnstable, Mass. 02668. Barnstable on the Cape seems an ambitious commute from the Boston area!

GenRad has announced a reorganization of its operations into three divisions. One of these, the Acoustics, Vibration and Analysis Division, is headed by **Harold T. McAleer**, Vice President of GenRad. Hal was previously general manager of the Electronic Instrument Division. His headquarters are in the Santa Clara, Calif., facilities and he reports to William R. Thurston, Company President. . . . Soil Testing Services, Inc., of Northbrook, Ill., has announced the appointment of **Clyde N. Baker, Jr.**, as President of the firm. Clyde has been with Soil Testing Services since 1954, serving in capacities as Project Engineer, Chief Engineer, Vice President, and Executive Vice President. He has had a broad experience with all aspects of the firm's geotechnical engineering business and will continue to serve as a Principal Engineer of the firm. . . . **Jim Warren** of James Ross Warren & Associates of Los Angeles, Calif., has recently run a one-day workshop on Determining the Potential for Improving Your Organization. Jim has been a management consultant for 15 years and has concentrated on the application of Behavioral Science for the last 12 years. His varied consulting experience includes the following fields: high-technology companies; heavy manufacturing industry; aerospace; health care; insurance; education; government; community agencies; and other non-profit organizations. Prior to becoming a consultant, Jim was Program Manager for Pacific Semiconductors, and was Staff Director of Technical Programs for TRW Electronic Components Group. He has an M.B.A. from the Harvard Business School.

Two of our classmates continue to make their marks in the university world. **Alwyn C. Scott**, Professor of Electrical Engineering at the University of Wisconsin, has just written *Neurophysics.* The book explores the contributions the "hard" physical sciences can make to an understanding of neural mechanisms. Topics discussed included biochemical reactions and the movement of electrical impulses within the brain. Dr. Scott has taught at Wisconsin since 1961. He holds several patents and is the author of *Active and Nonlinear Propogation* (Wiley, 1970.) . . . The Coblentz Society, a national organization of scientists who work in the field of infrared spectroscopy, has elected Bowdoin College Professor **Dana W. Mayo** a member of its Board of Management. Dana is the Charles Weston Pickard Professor of

Chemistry at Bowdoin.

The death of our classmate, **William A. Hey**, Bainbridge Isle, Wash., has been reported. Mr. Hey, who was a graduate of Course XVI Aeronautics and Astronautics, died on July 13, 1977.

The death of **Charles W. Sorenson**, as a result of a tragic bicycle accident, has been reported by his wife Christine. Mr. Sorenson held a Master of Science Degree from M.I.T. in Chemical Engineering and did a fine job with General Electric's Knolls' Atomic Power Laboratory. He became disillusioned with the nuclear business and left General Electric to take a much lower paying job as a mathematics teacher at the Albany High School in Albany, N.Y. He was an outstanding teacher and counseled many able students to apply for admission to M.I.T. Last fall, while riding a bicycle home from school, he was hit by an automobile and remained in a coma for over six months before he died. Classmates such as Charles Sorenson will always be remembered as a credit to M.I.T. and to this country. — **Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, Mass. 01741; **Richard F. Lacey**, Assistant Secretary, 2340 Cowper St., Palo Alto, Calif. 94301

53

Apparently, almost all of you have writer's cramp. Thus, there is less than a surfeit of news — and most of it is bad, I am sorry to say. First, **Y.C. Ho** reports that he is Gordon McKay Professor of Engineering and Applied Mathematics at Harvard, but is a visiting professor of electrical enigneering at M.I.T. for the current academic year. Second, I am sorry to report that two of our classmates, **Emanuel Schoenberg** and **Elmo Pacini**, died during recent months. No further information is available on Mr. Schoenberg, but a newsclipping indicates that Mr. Pacini was a system product manager for Dynamics Research Corp. and died at the Charles Dana Cancer Center in Boston after a long illness. Should any of you have additional information, I will be happy to report it in a subsequent column.

Make sure that our 25th Class Reunion weekend (June 8 to 11, 1978) is blocked out on your "things to do in the coming year" calendar. And please send some news. — **Martin Wohl**, Secretary, 7520 Carriage Ln., Pittsburgh, Penn. 15221

54

Mike Ariens is now President of the family business. He sees a change in how he allocates his time in that he now has less hands-on control and is doing more forward planning. There is always a certain sadness when you get out of the daily contact with the action out on the floor.

Bob Avakian recently changed jobs but we haven't caught up with his new position yet. . . . **Dave Howes** has moved out of his old diggings into another house in Carlisle. His new one adapts more to his new life-style. . . . **Bob Warshawer**'s father passed away in New York City. Bob is selling the family business and settling the estate. Bob is a Program Manager at G.T.E.-Sylvania. He successfully managed the development of a new communication system for the Navy. A radio installed aboard submarines is now able to receive messages while submerged below the surface of the water. Bob and his staff are recognized as having accomplished an outstanding achievement. — **Dave Howes**, Secretary, Box 68, Carlisle, Mass. 10741; Assistant Secretaries: **Chuck Masison**, 76 Spellman Rd., Westwood, Mass. 02090; **Lou Mahoney**, 6 Danby Rd., Stoneham, Mass. 02180

56

Well, it has been about a year and a half since I last wrote a report and about a year since I left Boston. Warren certainly did a great job of picking up the pieces, but deadlines are impossible from far-off Greece, whereas in Minnesota the Post Office regularly schedules dog sleds, pony express, etc.

Virginia Coburn Clarke has recently been appointed Director of Religious Education at Channing Memorial Church in Newport, R.I. She continues to be a family counselor in the drug unit of the local mental health center.

Ben Lightfoot reports in from his listening post at Los Angeles International Airport: **Ernest Wolff** is with Aerospace Corp., responsible for the dimensional stability test laboratories, and he also chairs symposia on the subject. **Jerry Sozio** is at TRW Systems Group in Redondo Beach, apparently also the local contact for the Course XVI subgroup on the West Coast. **Clark Weissman** is now with System Development Corp. after many years with North American Aviation.

Paul Luckett has checked in; after a number of years trying to help Beaunit survive, Paul is now President of Penn Athletic Products, subsidiary of General Tire and Rubber.

On a more sober note, last spring we had a cheery note from **Margaret Young** telling about her latest mountain climbing effort in Bolivia. Margaret is a foremost mountaineer, climbing major peaks throughout the world. During August, she visited her parents on Cape Cod and was thrown from a horse, breaking her back. In the fall she was in the rehabilitation unit of Tufts Medical Schod. Our best wishes to her for a brighter new year. — Co-Secretaries: **Bruce B. Bredehoft**, 7100 Lanham Ln., Edina, Minn. 55435; **Warren G. Briggs**, Northeastern U., Deree College, Box 472, Athens, Greece (to July 1978).

57

The news from alumni has been very scarce. I am hoping that the New Year will bring more information on your whereabouts and activities.

Silvester Pomponi of Bedford, Mass., was recently awarded the Cross of Aeronautical Merit, First Class, by the Spanish Air Force at a special ceremony at the Air Ministry, Madrid, on October 14. Presentation of the medal, the highest peacetime award of the Spanish Air Force and a rare distinction for foreign civilians, was made by General Alfaro, Chief of the Spanish Air Force. The award is in recognition of Mr. Pomponi's contributions as chief technical advisor on the joint U.S.A.F./Spanish Air Force program which developed an automated air defense system for Spain. Mr. Pomponi, now a technical department head for the MITRE Corporation of Bedford, led the MITRE technical team which designed the system. The system became operational in September, 1977, and is considered the most modern air defense capability to date.

Alfred Hoch was recently featured in the November 12 issue of *Stamp Collector.* Alfred, who lives in Somerville, Mass., is the father of four teenagers. He is responsible for Quarterman Publications, a part-time "hobby" of his. He hopes it will grow into a strong, viable business. Presently, his organization is a privately held corporation with four stock holders. The *Stamp Collector* article describes how Al became interested in philatetic books. Anyone interested in reading the entire article should request a copy of the 11/12/77 Spotlight newspaper from the *Stamp Collector.* — **Frederick L. Morefield**, Secretary, 285 Riverside Dr., New York, N.Y. 10025

58

February brings only good news, folks. And that is the 20th Reunion of the Class of '58 is shaping as a fabulous, splendiferous weekend. Back in December, just before the holidays, **Frank Tahmoush** assumed the duties of Reunion Chairman and he and the committee have been hard at work ever since planning the big event. According to Publicity Chairman, **Dick Barone**: "A veritable gaggle of great goodies — from bike riding and mini-marathons to sailing and sun-soaking — awaits you at the Harborview June 9 to 11. Set sail from Woods Hole to Martha's Vineyard Island and leave the weeds, the mortgage, the teenagers, and the job behind. By the time you reach the light-

Southeast Asia: When You're On the Outside Trying to Look In

How can an American successfully do business in Southeast Asia?

The secret is patience — patience with reluctant technology and patience with people whose traditional informality in business leaves them unprepared to negotiate with non-Asians for whom they feel distrust and suspicion.

The American goes into Southeast Asia with two handicaps, says Theodore H. Korelitz, '56, of Badger America, Inc.:

— He is the victim of that "general feeling of distrust of westerners" which all Asians seem to hold, probably the result of "long-term exploitation" by European colonizers and — later — unenlightened European and American businessmen.

— He is competing with English, French, and Japanese businessmen whose governments offer financial terms and conditions for export sales which are often far more attractive than those of the U.S. "The bureaucracy and red tape" associated with loan applications to the U.S. Export-Import Bank are often "much more complex" than other countries', write Mr. Korelitz and his colleague, E.H. Martel, in Badger America's magazine.

Southeast Asia's reluctant technology is a lesser problem. In Indonesia, for example, it's "not unusual" to try 30 or 40 times before finally achieving a telephone connection. So most people adjust to doing more business in person and less by telephone.

But cultural differences are harder to deal with. The typical Asian male is a "super chauvinist" in comparison to any westerner; most of his business dealings are arranged with friends on the basis of verbal understandings and mutually understood moral obligations. Americans, turned off by the Asians' social traditions, are seldom in a position to do business informally. And Asians' traditional mistrust of Europeans means that they do not like cost-plus or fixed-fee work; instead, they insist on lump-sum contracts which are hard for Americans to write because of their unfamiliarity with local conditions which will determine costs.

But Messrs. Martel and Korelitz are optimistic: the potential market in Southeast Asia is "huge," they say, and — despite "fierce competition" — the rewards will be large for American companies which make the necessary sales commitment. — *J.M.*

Roy Mennell, '56, and his wife Shelia, (above) operate a real estate agency in Newton, Mass.

Bill Northfield and his wife Sandy (below) appeared at the Class of 1956 20th Reunion just before Bill became President of Micon Industries in Oakland, Calif.

house at Harborview in Edgartown, you will be light-years from everything except a wonderful time with old friends, fantastic food, and a non-stop (well, almost) weekend to remember. So, shuffle those papers and rescue that announcement, send in your class dues and the reply card saying you will be there to share the fun. Even more of your classmates and friends will be there this year, so come on in — the water's fine!"

During the past year, **Mel Copen** and I have been in touch on several occasions concerning various consulting projects. Now, Mel has just recently assumed the post of Associate Dean for Academic Affairs at Georgia State University, College of Business Administration. Prior to his stint as a consultant, Mel was Director of International Planning at Gould, Inc. in Chicago. He has also been a faculty member at both the University of Houston and Harvard University. His industrial experience includes Westinghouse, the U.S. Department of Agriculture, and General Electric. . . . **Jim Perrin** was recently nominated by the U.S. State Department to be a representative to an International Symposium in Vienna, Austria, sponsored by the International Atomic Agency; Jim presented a talk pertaining to reactor safety.

Jim Braman is on the move again, and this time his letter comes from Montgomery, Ala., where he says: "I am now a member of the faculty of Air University's Leadership and Management Development Center here which is quite a bit different from being the Commander of a Civil Engineering Squadron in the Upper Penninsula of Michigan. Different climes and different times!" . . . Another letter from up-country Vermont from **Bill Hauke** who writes: "Carol and I now have four children: David 15, Steven 13, Sandra 11, and Martha 6. Keeping busy in the construction business building 30 to 40 homes per year and also building and managing shopping centers. Hope to see some of the Phi Kappa Sigma 1958 grads at the Reunion next year!" We hope so too! Keep those cards and letters coming! — **Michael E. Brose**, Secretary, 30 Dartmouth St., Boston, Mass., 02116

61

Only one card arrived during the last couple of months — from **Grady Harris** who writes that he is Vice President of the Division of Engineering at Baxter Labs in Deerfield, Ill. Grady says that he "lives in Lake Forest with his wife, Diane (a Montessori director) and our two children. My current hobbies are winemaking and tennis. Last summer our vacation in Denmark and Austria was a pleasant change of pace from business travel. I do miss the New England slopes."

A news release from Carnegie-Mellon University in Pittsburg reports that **Robert Kaplan** is now Dean of the Graduate School of Industrial Administration. The release mentions that he has two daughters, Jennifer (8) and Dina (5), and that his professional interests have been in social security and problems of municipal and state pension plans. Congratulations, Bob.

Finally we hear that **C. Anthony Junker**, a partner in Ueland and Junker, Architects and Planners, in Philadelphia, was awarded by the Montgomery County Planning Commission for the design of a 16-unit, low-income condominium project in Ardmore, Penn. — **Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, Mass.

62

Tom Sheahen has been awarded an American Physical Society Congressional Fellowship, and is now working on Capitol Hill as science advisor to Senator Mark Hatfield of Oregon. After September, 1978, he plans to return to his position with the Office of Energy Conservation of the National Bureau of Standards. . . . **Jeremy R. Goldberg**, his wife Marcia, and their two children Eliot (7) and Devra (6) toured Israel. For the children's first visit, they arranged their own itinerary. It was a learning experience to bring home to the Jewish Day School of Greater Washington, where Jeremy is on the Board of Directors. . . . **Martin Klein**, President of Klein Associates, Inc., Salem, N.H., announced the release of a new Klein Model 521 Side Scan Sonar Recorder — **Gerald L. Katell**, Secretary, 7 Silverbit Ln., Rolling Hills Estates, Calif. 90274

63

Another sparse month, news-wise. Fortunately I had a call from one of you to flesh out the column. Only two notes in my mailbag. **Elliot Bird** has been elected chairman of the math department at C.W. Post Center of Long Island University. Elliot invites any classmates in the Nassau County area to give him a buzz at 516-484-0991. . . . **Ron Jansen** is now working at D.E.C. in Maynard, Mass. As we reported here last month, Mrs. **Jansen**, nee **Chriss Huk**, works at Millipore Corp. in Bedford. The Jansens and their two children live in Brookline.

My caller was **Larry Beckreck**, who was in Framingham taking a training course in computer sales. Larry's company, Genesys, has become the U.K. sales rep for Prime Computers. Larry also passed along some news of our Boston area classmates who are not as communicative. Margie and **Larry Krakauer** are alive and well and living in Wayland, Mass. Larry is with Codex, a maker of telecommunications equipment and modems. Carolyn and **Ira Blumenthal** also hosted Larry. Ira is still with American Scale and Conveyor. Carolyn is currently into cobol programming. **Pete Van Aken** is still with the administration at Brandeis. Wife Carol, M.I.T. '65, is still at M.I.T. The Van Akens live in Winchester. That represents the sum total of my news.

The parting words are on the subject of the reunion. The first mailer mentioning the reunion was sent out by class president **Garry Stone** back in mid-November. By this time I am sure we will have received additional details. The reunion is planned for the first week of June on the M.I.T. campus. Having the get-together in Cambridge will make it more accessible to many of you, and give you a chance to revisit your old haunts. Make your plans now for being there. Boston is lovely at that time of year. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, Calif. 92715

64

The mail bag is almost empty. There were only three alumni fund envelopes with news. Please write or next month there may not be a column (our usual lament).

Thomas H. Baker writes that he spent 11 years with Hewlett-Packard in Loveland, Colo., where he designed instruments and integrated circuit systems. This year Tom is a visiting professor at North Carolina A. & T. University in Greensboro. He is helping to upgrade the Electrical Engineering Department in the area of digital electronics. The Bakers are the proud parents of four children.

Now in private practice as a consulting engineering geologist is **Donald Reed**. He was formerly Chief Geologist and Vice-President of Haley & Alrich, Inc., consulting geotechnical engineers and geologists.

Stanley Hallet is still at the University of Utah as Associate Professor of Architecture. He is an active filmmaker with his wife, Judith. They just made a film on the Nomads of Badakhshan in Afghanistan on a Fullbright grant. He is also publishing a book, *Traditional Architecture of Afghanistan*, to be out this April. Stanley also opened an active architectual office: Hallet, Heimonson & Associates, doing hillside housing.

I saw Barbara and **Carl Uhrmacher** and their son, Mark — here for the day early in December. They were going on vacation the next week: first, a cruise to the islands and then a week in Florida. They're all fine and, like us, send everyone a wish for a happy new year.

George (my eldest son) and I spent the day at Memorial Stadium in Baltimore late this fall. The Colts pulled it out over New England, 30-24, a kind of mixed-emotions game for us transplanted

New Englanders. George rooted strongly and continuously for Baltimore, no doubt a factor in their victory. The rain was all around us and it poured most of the way to and from Don's (Goldman of '65) house, but not one single drop disturbed the game (even though it was drizzling in the parking lot when we arrived). Part of the reason for the football outing was a little "equal time and attention" for each child. We've just finished about six months of non-stop (every three weeks) tonsilitis with Lewis. Finally, the tonsils came out (two days ago), so you can imagine who's been getting all the parental attention lately. One positive aspect of the whole thing was getting to know the Children's Hospital National Medical Center. You couldn't wish for an environment or staff more tuned to a child's needs and ways. All rooms (most of which are private) have sleeping facilities for a parent, and a general atmosphere designed to be "an extension of home" as much as a hospital room ever can be. Well, they do an outstanding job at Children's. We all hope never to need such facilities for our loved ones, but you couldn't ask for a finer place when and if the time comes.

Have a good year; support our dear alma mater; and please write! — **Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, Md. 20854

65

Bruce Golden continues to practice law and make music in Chicago. His jazz-rock group has played on the Richard Daley Plaza in Chicago and at parties given by the DuPont Corp. and Cameo Container Corp. Bruce will be featured in the Harvard Law School's alumni magazine in an article about lawyer-musicians.

You can see that I did not forget this month; you simply have not been writing. Next month may be even shorter! — **Edward P. Hoffer**, M.D., Secretary, 12 Upland Rd., Wellesley, Mass. 02181

66

George Berbeco writes that he started a new company, Charleswater Products, which makes conductive and anti-static materials for medical and electronics applications. . . . **Leonard Zacks** also started his own Chicago-based firm, Zacks Associates, a quantitative consulting service for investment management organizations. He also announces the birth of his second child, Danielle, born January, 1977. . . . **Irvin M. Asher**, still single, is living in Silver Spring, Md., and is a Science Advisor (Biophysics) to the F.D.A., who has already taken him to Egypt twice. He enjoys visits from classmates.

Martin Melnick is presently Advanced Westar Payload Design Subproject Manager for the TDRSS Program at TRW Systems in Redondo Beach, Calif. Recently he and his wife, Doris, had their first child, Matthew Aaron. . . . **Donald Deangelis** is still Research Associate in the Environment Sciences Division, Oak Ridge National Laboratory. He is preparing a book on Systems Ecology. His first child, Renee, was born October 31, 1977. . . . **Richard Leslie** spent four years in research with Dow Chemical Co. after obtaining his S.M. in chemical engineering. Then Rich spent one year as a deckhand on a small cruise vessel, three years teaching at a New Hampshire private school, and two years at Amos Tuck School for an M.B.A. He is currently working as Internal Consultant for L.L. Bean in Freeport, Maine.

Keep the updates coming. News is a little sparse. — **Paul Rudovsky**, Secretary, 340 East 64th St. New York, N.Y. 10019

67

Jearl Walker's 295-page physics book entitled *Flying Circus of Physics With Answers* is in its second edition. The book provides physically rigorous answers to more than 600 problems such as: why

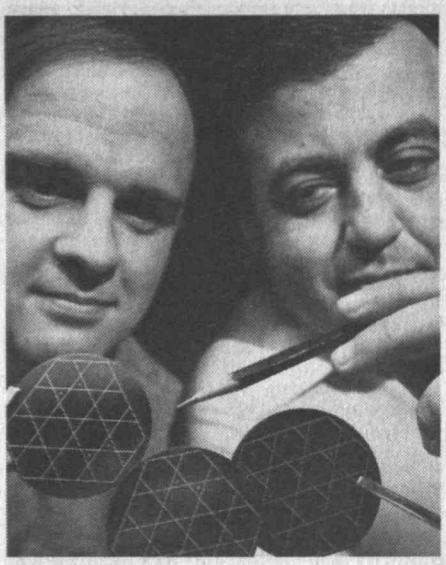
A "Significant Advance" in Making Semiconductors at General Electric

To make a semiconductor device, grow a crystal of silicon of the highest possible purity. Slice it into thin warfers. Then to each wafer add a small and precise amount of an impurity — called a "dopant."

A new way to accomplish this third step has now been reported by General Electric's Research and Development Center, the work of Thomas R. Anthony and Harvey E. Cline, '62; G.E. calls it "one of the most significant advances in the production of semiconductor components in the past decade."

The new technique — called thermomigration — is easily described: one side of the silicon wafer is heated while the other side is cooled; the temperature difference forces the "dopant" — in the form of a liquid — to migrate through the wafer, from the cooler to the hotter side.

Thermomigration takes place in minutes; the best previous method for doping wafers required nearly a week. And the new process works at temperatures several hundred degrees below those required previously. In addition to these savings of time and energy, the size, shape, and concentration of doped regions is more easily controlled. James W. Ritcey, Manager of G.E.'s Semiconductor Products Department, is enthusiastic: he talks about "whole new classes of semiconductor devices that never existed before."



Harvey E. Cline, '62 (right) and Thomas R. Anthony are credited with a new process — called thermomigration — which promises to reduce energy requirements and increase the yield in "doping" silicon wafers to make semiconductors. Both are members of General Electric's Research and Development Center, Schenectady.

can you hear the sea in a conch shell? How can stones skip across the water? What produces the atomic cloud's mushroom shape? Why do geese fly in a V? How does a cat land on its feet? Wht doesn't a fire-walker get burned? The *American Journal of Physics* recommended the book "without reservation to everyone who enjoys physics . . . and who wants to learn more about its application to real phenomena." Jearl teaches physics at Cleveland State University. . . . **John Schwarz** writes: "I completed two years of active duty in the Navy in July and have just opened my practice in ophthalmology at the West Medical Building of Union Hospital in Lynn, Mass. We purchased a home in Lynnfield and love life on the North Shore. My wife Nancy recently received her Massachusetts real estate broker's license and will be working part-time in that area. I have become a serious collector of antique electric trains and would like to hear from anyone with a similar interest, especially American Flyer." . . . **Bob Hardt** is Associate Professor of Mathematics at University of Minnesota. — **Jim Swanson**, Secretary, 669 Glen Rd., Danville, Calif. 94526

68

Flash! We have received from **Rick Lufkin** the first firm details about the reunion this June. If you have not received any mailings about it by the time you read this, please contact us. The reunion begins on Friday, June 9, with a cocktail party at M.I.T. Historical Collections. Saturday afternoon will feature a clambake at Duxbury Beach, and that evening there will be a dance/boat cruise around Boston harbor. There will be other general alumni activities including a Thurday night Pops concert and children's activities including babysitting. We are looking forward to seeing you there so circle the dates now.

Shan Cretin reports the birth of her daughter, Lauren Keeler, on July 13, Shan is still teaching at U.C.L.A. and enjoys the California weather and life in general. . . . Last August, **Tessa Orellana** married Morey Gardner. They both recently finished Infectious Disease Fellowships at the University of Chicago and have joined the faculty of Washington University Medical School.

Back in Beantown, **Paul Ware** is still working for Polaroid as a Senior Quality Assurance Engineer in the Camera Division in Dedham. His evaluation lab performs all camera division hardware testing for standard and new products. . . . In a warmer climate, **Dave Ellis** is contracts manager and general attorney with Paradyne Corp. in Largo, Fla. (near Tampa). He moved to Florida from the New York/New Jersey area last July and really enjoys the swimming, biking, sailing, and tennis there. His wife, Sue, is a school psychologist in the Pinellas County School System and just opened a private practice. . . . **Bob McCrory** has been promoted to senior scientist and group leader in the Theory and Computation Group of the University of Rochester's Laboratory for Laser Energetics. . . . Finally, **Michael Yokell** is now with the Solar Energy Research Institute in Golden, Colo.

We're looking forward to seeing everyone in June. — **Gail** and **Mike Marcus**, Secretaries, 2207 Reddfield Dr., Falls Church, Va. 22043

71

It's spring in December here in Texas with 70 degree temperatures. The winter weather in Boston is something I do not miss.

Stephen C. Ehrmann writes: "I recently finished two years of full-time consulting for the Evergreen State College, a nontraditional college in Olympia, Wash. My work was aimed at demonstrating that Evergreen could become a more effective educator through self evaluation. I was part evaluator, part teacher. Now I'm working full time on completing my doctoral dissertation (M.I.T. Interdepartmental), 'A Study of Integrative Processes Within A Civil Engineering Department.' Leslie continues as a design consultant."

Air Force Chaplain (Captain) **Edward I. Brogan** reported for duty at Seymour Johnson Air Force Base in North Carolina and will serve with a unit of the Tactical Air Command. Edward received his Master of Divinity degree from Gordon Conwell Theological Seminary at South Hamilton, Mass. He is married to the former Sandra Currie. Please keep in touch. — **Hal Moorman**, Secretary, P.O. Box 1808, Brenham, Tex. 77833

72

Bob Schulte writes, "Susie and I have returned home to St. Louis where I am employed as a manager at Nixendorff-Lloyd Chain Co. Susie is currently a Director at a new residental facility in St. Louis County."

Bradford Dulmaine recently joined Universal Specialty Steel as a research metallurgist in Pittsburgh. "This is a much better town than people give it credit for. The biggest problem here isn't smog anymore; it's the incredible traffic jams," he says.

Richard Wille is in Mexico working for Johnson & Johnson as Division Manager for Hospital and Diagnostics products. . . . Robert ('70) and **Margaret Turek** have a new son, Benjamin Anthony, born October 16. . . . **Paul Karger** is teaching computers at the Air Force Academy, after receiving his master's from the Institute last year.

Stan Hoffman recently received his Ph.D. from Caltech in biology and is doing postdoctoral work at the Rockefeller Institute in New York. He and his wife, Barbara, have an apartment in Manhattan.

Mark Aquino writes, "Despite all the diapers and my bridge playing, Suzanne somehow manages to keep her sense of humor. She wears an apron that says, 'For this I spent four years in college?' My kids are just great. Lauren is going to be a 'heartbreaker'; she is now 2. Matt, 1, is a real hellion. I'm now out of the Army and working in Production Management for Polaroid in Cambridge. I was flattered by an article in the *New York Times* which lauded a really spiffy play I managed at the bridge table." — **Dick Fletcher**, Secretary, 135 West St., Braintree, Mass. 02184

73

Lynn Snyder recently joined "Renascence Project" staff as coordinator of their library. She is in charge of the adult education classes and library facility. Renascence, for those interested, is a Kansas City-based concern seeking alternatives to future social, economic, and environmental conditions. An enclosed brochure was fascinating reading, and those interested are encouraged to write for information at 3611 Walnut, Kansas City, Mo. 64111.

Rich Haas is interning at Mt. Sinai in New York and is very busy, no doubt. . . . **Mike Scott** is a product manager for Hewlett-Packard in Cupertino, Calif. He bicycles the 15 to 20 miles to and from work, and is learning to kayak this fall. Well, Mike, I guarantee *that* will chill you. Everyone knows you can't have your kayak and heat it, too. . . . **Francis Keil** is a professor of psychology at Cornell, after Ph.D.ing at Penn last summer. . . . **Bill DeCampli** expects to finish a Ph.D. in Harvard's Physics Department sometime this year. He lived with **Mike Scott** last summer while at Ames Research Center. **Cyndy Stratton** married Martin O'Malley on June 25, and, after honeymooning in Ireland returned to Houston where she is a C.P.A. with Ernst and Ernst and he is an attorney with Zapata Corp. . . . **Jeff Rosenfeld** is working as a geochemist for Continental Oil in Ponca City, Okla.

Carlton Sockwell who had been teaching in and about Boston, is now a middle school math teacher for the Bakie School in New Hampshire. . . . **Gregg Oppenheimer** won first prize of $250 in A.S.C.A.P's 1977 Burkan Memorial Competition for essays on copyright law. His was entitled, "Originality in Art Reproductions: 'Variations' in Search of a Theme."

Your lean and hungry servant can be seen daily at Boston's Charles Playhouse, starring as El Gallo in that long-running musical, *The Fantasticks.* Forsaking the world of Gilbert and Sullivan for the, alas, more lucrative world of American musical theatre, I have no doubt prostituted my art for a mere piece of silver. But come see it anyway. It's an enjoyable evening and a way to meet some of your classmates. If the Reunion Committee doesn't get much help from you all, we ain't gonna see each other in June! — **Robert M. O. Sutton**, Secretary, 37 Fairbanks St., Brighton, Mass. 02135

75

Sorry I missed the last issue; now I'll catch up on two issues' worth of news.

Congratulations (somewhat belated) are in order for two of our classmates. **Ernest C. Brown** was married on August 13 to Barbara A. Sheridan (Wellesley '76). He's finishing his J.D./M.S. at Berkeley. . . . **Bill Jones** married Heather Menzies on September 17, 1977, in Charlotte, N.C. Incidentally, Heather is the daughter of W.C. Menzies, Jr., class of 1955.

Thomas Olsen is at work on a Ph.D. in physics at the University of Southen California where he shares an apartment with fellow classmate **Ken Luey**. Tom is studying multiphoton processes and is dreaming of a post-doctorate in Europe. . . . **Ken Deemer** worked for the past two years for Hughes Aircraft Co. in Los Angeles. He's now studying for his M.B.A. at Carnegie-Mellon University. . . . **Marya Sieminski** reports that her current employment is as Community and Economic Development Assistant to Senator Donald Riegle. She's working in his Detroit office.

Mike Kozinetz dropped me a note and had this to say: ". . . still working for Badger. This time I'm working for Badger Plants, Inc., in Cutlettsburg, Ken., and we're constructing an H-Coal pilot plant for a bunch of oil companies and E.R.D.A. The project will eventually turn out a unit that makes petroleum distillates from coal. It's pretty interesting and I'm a piping engineer these days. I bought a house in Bradrick, Ohio, of all places, and am having fun living out in the boondocks and putting my place into shape." . . . Finally, we have a corporate president in our midst. **Miles R. Fidelman** is living in Boston. He's self-employed as President of the Network Technology Corp., specializing in data communications and computer services.

Please write when you have a chance. — **Jennifer Gordon**, Secretary, 22 Centre St. #9, Cambridge, Mass. 02139

76

Boreas has sent his fingers grasping for me. As a result the news this month is, alas, brief, as I have successfully striven to remain out of his clutches.

From **Tom Gaskin** we have an interesting note. "Beginning in December, I will be working a six-month temporary duty in Saudi Arabia as a construction inspector for housing being built at a Royal Saudi Air Force Base by American contractors, and supervised by the U.S. Air Force."

I ran into **Barbara Slocum**. She is working for Saunders Associates in Nashua, N.H., doing literature searches in their technical library. She is enjoying the beauty and lack of taxes in New Hampshire very much.

Gary Buchwald has changed jobs, going from an actuary with New England Life in Boston to a computer scientist with The Computer Company in Waltham. I suspect he has left the actuary business for good.

Erland Van Lidthe de Jeude is working for A.D.P. Network Serivces in N.Y.C. He has moved from Connecticut to Brooklyn, and rides the subway to Manhattan and his job. When I last spoke with him, he was having a great time at work.

Rich Sobel is in Hershey (Penn.) Medical School. Our congratulations, of course. . . . **Gary Kaitz** has finished his S.M. (M.C.P.) and has relocated to D.C. and a job.

Do write, even if the news is outrageous. — **Arthur J. Carp**, Secretary, 67 Badger Circle, Milton, Mass. 02186

ALUMNI TRAVEL PROGRAM 1978-79

This special travel program, to some of the most interesting areas in the world, has been especially designed for alumni of Harvard, Yale, Princeton, M.I.T., Cornell, Dartmouth, Univ. of Pennsylvania and certain other distinguished universities and for members of their families. It is consciously planned for persons who normally prefer to travel independently, and covers lands and regions where such persons will find it advantageous to travel with a group.

The itineraries are designed for the intelligent traveler, and offer an in- depth view of historic places, ancient civilizations, archeological sites and artistic treasures, as well as interesting and far-flung cultures of the present day and spectacular scenery from virtually the four corners of the globe. The programs are, however, also planned to incorporate generous amounts of leisure time and to avoid unnecessary regimentation so as to preserve as much as possible the freedom of individual travel, while utilizing the savings and the practical convenience which group travel can offer.

Considerable savings have been obtained by using special reduced fares offered by the world's leading scheduled airlines, fares which are generally available only to groups or in conjunction with a qualified tour and which offer savings of as much as $500 and more over normal air fares. In addition, special group rates have been obtained from hotels and sightseeing companies. By combining these savings with a careful selection of the finest available hotels and facilities, it is possible to offer travel arrangements of the highest standard at moderate and economical cost.

AEGEAN ADVENTURE — 23 Days: The archeological treasures of classical antiquity in Greece and Asia Minor and the islands of the Aegean, with visits to Constantinople (Istanbul), Troy, Pergamum, Smyrna (Izmir), Sardis, Ephesus, Epidauros, Mycenae, Olympia, Delphi and Athens, as well as a cruise through the Aegean to the islands of Crete, Santorini, Mykonos, Rhodes and Patmos. Departures April through October.

MEDITERRANEAN ODYSSEY — 22 Days: An adventure into realms of antiquity in the western Mediterranean, with the ruins of Carthage and the Roman cities of Africa in what is now Tunisia, the splendid Greek temples of Sicily (including the famed "Valley of the Temples" at Agrigento and the ruins of Syracuse, the city of Archimedes), the remarkable Norman churches of Palermo, dating from the age of William the Conqueror, and the fortress cities of the Crusader Knights of St. John on the island of Malta. Departures March through October.

VALLEY OF THE NILE — 17 Days: A detailed view of one of the greatest civilizations the world has ever known, the civilization of ancient Egypt along the valley of the Nile. The itinerary includes Cairo, the pyramids of Giza, Sakkara, Dashur and Meidum, Memphis, Abydos, Dendera, the great temples and monuments of Luxor, including the Valley of the Kings and the tomb of Tutankhamun, and a cruise on the Nile of Upper Egypt to visit Esna, Edfu, Kom Ombo and Aswan, as well as the great monumental temples of Abu Simbel near the border of the Sudan. Departures January through December.

THE ORIENT — 29 Days: A magnificent survey of the Orient, including the exotic temples and palaces of Bangkok and the ruins of ancient Ayudhya, the great metropolis of Singapore, the enchanted island of Bali with its unique artistic heritage, the famed port of Hong Kong on the border of Red China, and a comprehensive visit to Japan which places special emphasis on the cultural treasures and the tranquil beauty of classical Japan at the historic city of Kyoto and at Nara, Uji, Kamakura and Nikko, as well as the mountain scenery of the Fuji-Hakone National Park and the modern capital at Tokyo. Optional visits are available to the ancient temples of central Java and the art treasures of the National Palace Museum in Taiwan. Departures March through November.

BEYOND THE JAVA SEA — 32 Days: A remarkable journey through the tropics of the Far East, from the port of Manila in the Philippines to the tea plantations and ancient civilizations of Ceylon, the Malay Peninsula, the Batak tribes of Sumatra, the ancient temple ruins of Java, the fabled island of Bali, headhunter villages in the jungle of Borneo, and the unforgettable beauty of the lights of Hong Kong. Departures January through November.

MOGHUL ADVENTURE — 30 Days: The great historic and cultural heritage of India, combined with the splendor of ancient Persia and a journey into the high Himalayas in the remote mountain kingdom of Nepal: imposing Moghul forts, ancient temples, lavish palaces, the teeming banks of the Ganges, snow-capped mountains, picturesque cities and villages, and the Taj Mahal, culminating with the famous mosques of Isfahan and the 5th century B.C. palace of Darius and Xerxes at Persepolis. Departures January through November.

SOUTH AMERICA — 28 Days: An unusually comprehensive journey through the vast continent of South America, from the Inca ruins and colonial heritage of the western coast, amid the towering snow-capped Andes, to the great Iguassu Falls and the South Atlantic beaches of Brazil. The itinerary includes the colonial cities of Bogota, Quito and Lima, the great Inca centers of Cuzco and Machu Picchu, La Paz and Lake Titicaca, the magnificent Argentine Lake District at Bariloche, Buenos Aires, the Iguassu Falls, Sao Paulo, Brasilia and Rio de Janeiro. Departures January through November.

THE SOUTH PACIFIC — 28 Days: An exceptional tour of Australia and New Zealand, with Maori villages, boiling geysers, fiords and snow-capped mountains, ski plane flights, jet boat rides, sheep ranches, penguins, the real Australian "Outback," historic convict settlements, and the Great Barrier Reef. Visiting Auckland, the "Glowworm Grotto" at Waitomo, Rotorua, the Southern Alps at Mt. Cook, Queenstown, Te Anau, Milford Sound and Christchurch in New Zealand, and Canberra, Tasmania, Melbourne, Alice Springs, Cairns and Sydney in Australia. Optional extensions available to Fiji and Tahiti. Departures January through November.

EAST AFRICA — 21 Days: A distinctive game-viewing and photographic safari to the wilds of Africa, covering some of the greatest wildlife areas in the world. From the semi-desert of Kenya's Northern Frontier region and the vast game-filled plains of the south to the lakes of the Great Rift Valley and the snow- capped peak of Kilimanjaro, the itinerary includes Nairobi, the Nairobi National Park, Treetops, Meru National Park, Samburu Game Reserve, the Mt. Kenya Safari Club, Lake Nakuru National Park, Lake Naivasha, an extended stay in the great Masai-Mara Reserve, Amboseli National Park and Tsavo National Park, with optional visits to the coast at Mombasa and Lamu. Departures January through December.

Prices range from $2,295 to $3,575 from U.S. points of departure. Fully descriptive brochures are available on each tour, setting forth the itinerary in detail with departure dates, relevant costs, hotels used, and other information. For full details contact:

ALUMNI FLIGHTS ABROAD

White Plains Plaza, One North Broadway, White Plains, N.Y. 10601

Management Experts for the U.S.S.R.

Three Russians are now approaching the two-thirds mark in the Sloan Fellowship Program — the sixth, seventh, and eighth Soviet managers to earn M.I.T. master's degrees in the Program since its founding just before World War II.

Vadim V. Andronov, a specialist in energy management, will do a thesis on the management of world energy resources with emphasis on oil; he's especially interested in applications of computers to mathematical simulation.

Valentin Oushakov, who is on leave from his job as Director of Foreign Trade for the Ministry for Science and Technology, says he likes the Sloan Fellowship Program for its emphasis on practice instead of theory. "It is too late for me to study theory," he told David Mutch of the *Christian Science Monitor* late in the fall; "here the problems we study are from real life." His special field at the Sloan School is the structure and motivation of international corporations.

Boris G. Ivanov, who used to be a ship captain, is now a specialist in environmental protection; at the Sloan School, he's studying government-industry relations in the environmental field. He and his colleagues are sent to the Fellowship Program by the U.S.S.R. State Committee for Science and Technology.

I
Civil Engineering

Clifford S. Orloff, S.M. '70, is currently President, Public Services Planning and Analysis Corporation; beginning August, 1978, he will be Associate Professor, Graduate School of Business and Public Administration, Cornell University, Ithaca, N.Y. . . . **Joel Brainard,** S.M. '67, has been engaged in the analysis of energy systems at the Brookhaven National Laboratories . . . **Theodore Vander Els,** S.M. '66, is the Commander of the 9th Engineer Battalion in Aschaffenburg, Germany . . . At Purdue University, Indiana, **Anil S. Bhandari,** S.M. '76, is studying towards a Ph.D. in Transportation Engineering, in the department of Civil Engineering . . . Environmental consultants Camp, Dresser, and McKee, Inc., have announced the promotion of **William F. Callahan,** S.M. '65, to Senior Vice President of their Environmental Engineering Division.

II
Mechanical Engineering

Michael E. Crawford, whose background is in heat transfer, thermodynamics, and the fluid mechanics of turbulent flows, is Assistant Professor; he holds degrees from Arizona State and Stanford Universities.

Ernest G. Cravalho, Matsushita Professor of Mechanical Engineering in Medicine, is Associate Director of the Division for Medical Engineering and Medical Physics in the Harvard-M.I.T. Division of Health Sciences and Technology; it's a long title, and an important one: he will oversee all the Division's students who are candidates for doctorates in medical engineering and medical physics.

The American Society of Mechanical Engineers has presented its Henry Hess Award to **Robert J. Hannemann,** Sc.D. '75, for his paper, "Thin Film Conducting and Semiconducting Resistance Thermometers for Surface Temperature Measurement." . . . **Michael Feldstein,** S.M. '66, is the Department Manager of Storage Products Engineering at Data General Corp., Westboro, Mass., where he is responsible for the design and development of disc drives used as random access magnetic memories with several families of computers.

IV
Architecture

Six changes in the faculty were announced this winter.

Muriel R. Cooper, Media Projects Director at the M.I.T. Press who has been Lecturer in the Department, has been promoted to Associate Professor of Visual Studies; her teaching will be in the design of visual and verbal information in print. Ms. Cooper first joined M.I.T. as a graphic designer in 1953, and she has been associated with the M.I.T. Press since 1967.

Donald Corner and **Jenny Young** have received a joint appointment as Assistant Professor of Architecture. Both have been part of the Center for Environmental Structure at Berkeley specializing in the design and development of housing for Baja California since receiving their degrees from the University of California, Berkeley, in 1974.

Stephen K. Gregory, '72, who is completing work toward a Ph.D. in computer science at the University of Utah, is Assistant Professor; he's been Director of that University's Computer-Aided Design Laboratory.

Ronald L. MacNeil, '71, who has been Instructor in the Creative Photography Laboratory since coming to M.I.T. with the late Professor Minor White in 1966, is now Assistant Professor.

Allan S. Anderson, M.Ar. '60, and his wife, Barbara, have been honored twice — by the New York State Association for Architects and the American Institute of Architects, Westchester County — for their renovation and "recycling" of the Milton School, Rye, N.Y. He is also currently Architect in Residence for the White Plains public schools . . . **Robert L. Ziegleman,** M. Ar. '59, has been appointed Adjunct Professor at the University of Michigan; he has been developing a structural system for a pre-fabricated 200-bed hospital to be built in Houston, Texas, for barging to Guatemala . . . **Dean K. Boorman,** M.C.P. '51, continues his active city planning consulting practice in New Jersey, as well as serving voluntarily on the Liberty State Park Commission, working on development of the 800-acre site behind the Statue of Liberty and Ellis Island.

VI
Electrical Engineering and Computer Science

Four additions to the faculty were reported early this winter:

☐ **Randall Davis,** who completed his doctorate in computer science at Stanford University in 1976, has been appointed Assistant Professor; his undergraduate degree is in physics, from Dartmouth.

☐ **Irene G. Greif,** '69, Assistant Professor of Computer Science at the University of Washington, has returned to M.I.T. to be Assistant Professor. She completed her Ph.D. at the Institute in 1975, and she was Instructor in the Department in 1974-75.

☐ **James L. Massey,** Ph.D. '62, Freimann Professor of Electrical Engineering at Notre Dame, is to be Visiting Professor in the Department until May 1; he was Visiting Associate Professor here in 1966-67.

☐ **Michael M. Salour,** whose degrees are in physics from Harvard, is on leave from the Optics Section of the Physics Department at Imperial College, London, to be Assistant Professor of

Electrical Engineering from 1977 to 1980.

The third of a five-volume study guide on *Modern Control Theory* by Professor **Michael Athans,** Director of the Electronics Systems Laboratory, has now been published by the Center for Advanced Engineering Study. The guides are to accompany a series of 73 color videotapes on Modern Control Theory, one of 24 video-based subjects developed by C.A.E.S.

Stephen D. Shoap, S.M. '66, has left Bell Laboratories to join Lincoln Laboratory . . . **Peter G. Jessel,** Ph.D. '72, has recently joined the Digital Equipment Corp. as Manager of Advanced System Development, while continuing to be a Lecturer in Course VI . . . **John E. Rudzki, Jr.,** Ph.D. '71, has retired from the Air Force and joined the faculty of Trinity University, San Antonio, Tex., where he is also Project Manager of the newly established Regional Solar Energy Meteorological Research Site . . . **William B. Macurdy,** Ph.D. '62, has been appointed Executive Director of the Switching Systems Engineering Division at Bell Laboratories, Holmdel, N.J.

VIII
Physics

George Bekefi and **Alan H. Barrett,** both Professors of Physics, are the authors of *Electromagnetic Vibrations, Waves, and Radiation,* a textbook recently published by the M.I.T. Press (hard cover, $17.50).

Henry Helmken, Ph.D. '64, currently a physicist and lecturer at the Smithsonian Institute and the Harvard College Observatory, was a recent guest speaker at a meeting of the Lynn, Mass., Rotary Club, talking on "Frontiers in Astronomy." . . . **Robert D. Larrabee,** S.M. '55, has accepted a new position with the Semiconductor Technology Division of the National Bureau of Standards, Washington, D.C. . . . **David A. Campbell,** S.M. '75, is serving as a member of the technical staff of Ford Aerospace and Communication Corp., Newport Beach, Calif., and is Professor of Physics and Chairman of the Physics and Astronomy Department at Saddleback College, Mission Viejo, Calif. . . . At the University of South Florida, **Glenn A. Burdick,** Ph.D. '61, is a full Professor of Electrical Engineering.

Don Jarrell, S.M. '57, retired from the Navy and is now Program Manager for Advanced Concepts, Delex Systems, in Vienna, Virginia . . . **Charles Naiman,** Ph.D. '61, has been appointed Director of Laser Metalworking at Avco Everett Research Laboratory, Inc.

X
Chemical Engineering

Selim M. Sankan, Sc.D. '77, whose doctoral thesis accepted last year was on the manufacture of synthetic pipeline-grade gas, is now Assistant Professor of Chemical Engineering and Director of the M.I.T. Practice School at Oak Ridge.

Robert C. Lummis, S.M. '58, has been named Director of Scientific Computing for the Albert Einstein College of Medicine and its parent institution, Yeshiva University, Bronx, N.Y. . . . *Fundamentals of Numerical Reservior Simulation,* by **Donald W. Peaceman,** Sc.D. '51, has been published by Elsevier North-Holland; the book is intended for use by engineers in the petroleum industry. Dr. Peaceman is Senior Research Advisor for Exxon Production Research Company, Houston, Texas.

XII
Earth and Planetary Sciences

Roger G. Little, S.M. '64, has been elected chairman of the Nuclear and Plasma Society of the Institute of Electrical and Electronic Engineers, Central New England Chapter. He is the president of Spire Corporation, Bedford, Mass., a firm which he founded in 1969.

Richard Beger, S.M. '67, is a full-time instructor in Geology at Champlain Regional College, Lennoxville, Quebec, Canada . . . **Francisco Queral-Sune,** S.M. '68, is currently a professor in the Geology Department of the School of Engineering, National University of Mexico.

XV
Management

Five new faculty appointments at the Sloan School:

☐ **Carliss Y. Baldwin,** '72, is now Assistant Professor of Finance, having completed her doctorate at the Harvard Business School last June. Professor Baldwin studied economics at M.I.T., and she has been a Research Assistant at the Harvard Business School since receiving her master's degree there in 1974.

☐ **James S. Hekimian,** Assistant to the President at Northeastern University, is teaching management and policy issues at the Sloan School as Adjunct Professor of Management, part time. Professor Hekimian's degrees are from Harvard (A.B. 1954, M.B.A. 1952, D.B.A. 1962), and he was Dean of Business Administration for eight years and Vice President for Academic Affairs for one year before assuming his present duties at Northeastern.

☐ **Richard L. Schmalensee,** '65, has returned to the Sloan School from the University of California to be Associate Professor of Economics. Professor Schmalensee was Instructor in the Sloan School from 1967 to 1969 while working on his Ph.D. in economics, and he joined the faculty for one year in 1970; during 1972-73 he was Director of the Solid Waste Project for the Institute of Policy Analysis in La Jolla, Calif.

☐ Since earning his doctorate in economics in 1975, **Martin B. Zimmerman,** Ph.D. '75, has been a Lecturer in the Sloan School while working on research assignments for the M.I.T. Energy Laboratory. Now he is Assistant Professor, teaching subjects in economics and policy.

☐ **Michael B. Zisman,** who is completing his Ph.D. from the Wharton School at the University of Pennsylvania, is Assistant Professor of Management in the field of decisionmaking. He studied chemical engineering at Lehigh University (B.S. 1970) and systems engineering and operations research at the University of Pennsylvania (M.S. 1973), where for two years he was Director of Technical Services and Operations for the University Management Information Services. Effective August, 1977, **Tung-Po Lin,** Ph.D. '58, has been appointed to the Chairmanship of the Department of Mathematics at California State University in Northridge.

John J. Donovan and **Stuart E. Madnick,** '66, Associate Professors of Management Science, are co-authors of *Software Projects: Pedagogical Aids for Software Education and Research,* published this winter by McGraw Hill Book Co. The contents include projects and computer programs to help readers learn the design, implementation, and documentation of software.

John F. Harkness, S.M. '64, has been named Vice President and General Manager of the Plastics division of Harvey Hubbell, Inc., Newtown, Conn. . . . **Philip R. Marsilius,** S.M. '48, has been appointed President of the Producto Machine Company, Bridgeport, Conn. . . . **William D. Neal,** S.M. '73, has been promoted to Manufacturing Department Manager in charge of light-duty liquids making at Procter and Gamble's Ivorydale Soap Products plant, Cincinnati, Ohio . . . **Robert L. Woodall,** S.M. '65, has been appointed Manager, Coal Business Development in the Natural Resource Group of Dravo Corporation, Pittsburgh, Penn. . . . At Michigan State University, **W. Donald Weston,** S.M. '76, has been named dean of the College of Human Medicine.

Thurow: Abolish Corporate Tax

In an era when the nation is focusing on equity and progressive taxation, the corporate income tax is an irrational, counterproductive anomaly which should be abolished, says Lester C. Thurow, Professor of Economics. Instead, he wrote in the *Wall Street Journal* last summer, all corporate income — whether retained or paid out — should be "taxed as personal income to stockholders at rates appropriate to the income of each individual shareholder."

Among Professor Thurow's arguments:

☐ Considering corporate earnings distributed to stockholders as dividends, the familiar issue of "double" taxation is appropriate: the dividends are reduced by the corporation's 48 per cent income tax and further reduced by each stockholder's individual income tax.

☐ But retained corporate earnings, now taxed at 48 per cent, are also the property of the stockholders. To the low-income stockholder whose income tax rate is less than 48 per cent the corporate income tax is unjustly high, he writes, while "to the high-income stockholder the tax is a shelter or loophole."

☐ Interest payments are a deductible corporate expense, but dividends are not. This biases corporate capital structures away from equity and toward debt, when in fact an opposite bias is probably desirable "from the point of view of a healthy, vital capitalistic economy," wrote Professor Thurow.

☐ Since personal income taxes can be as high as 70 per cent (compared with corporate rates set at 48 per cent), corporations are biased by their wealthy stockholders — who are often corporate officers — to retain and reinvest earnings to increase the value of the stock rather than the amount of dividends. Without this bias toward retained earnings, Professor Thurow thinks, "the supply and demand for funds in the capital markets would increase, leading to greater economic efficiency."

☐ Eliminating the corporate income tax would reduce corporate expenses and thus reduce the prices of goods and services. Result: more sales, more production, more employment. — *J.M.*

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Honors from the Mechanical Engineers

Three members of the faculty were honored with four awards of the American Society of Mechanical Engineers during the Society's winter annual meeting in Atlanta late in the fall: to Professor **Robert W. Mann,** '50, the Society Medal for "eminently distinguished engineering achievement"; to Professor **Robert C. Seamans, Jr.,** Sc.D. '51, former Head of the U.S. Energy Research and Development Administration, the Ralph Coats Roe Medal for service and education; and to Professor **Nam P. Suh,** '59, Director of M.I.T.'s new Laboratory for Manufacturing and Productivity, the Gustavus L. Larson Award for "outstanding achievement in engineering and in education." In addition, Professor Mann received the A.S.M.E. Bioengineering Division H. R. Listner Biomedical Engineering Award for "pioneering contributions to and development of the field of bioengineering and for successful synthesis of engineering and medicine to aid the physically handicapped."

Two von Helmholtz Professors

The Hermann von Helmholtz Chairs in Health Sciences and Technology are now occupied by Charles H. Oman, Ph.D. '72, Associate Professor of Aeronautics and Astronautics and William M. Deen, Assistant Professor of Chemical Engineering. The two new posts, both in the Harvard-M.I.T. Division of Health Sciences and Technology, are the result of a 1974 grant from Becton, Dickinson and Co., a leading manufacturer of health care products.

Professor Oman, whose undergraduate degree is from Princeton, is associated with the Man-Machine Laboratory in the Department of Aeronautics and Astronautics; he is a specialist in sensory, motor, and neural systems. Professor Deen studied at Columbia and Stanford (Ph.D. 1973) and came to M.I.T. in 1976 to teach heat and mass transfer and such physiological processes as membrane transport.

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Morris Cohen, '33, Institute Professor and Professor of Materials Science and Engineering, Emeritus, was one of 15 U.S. scientists given the 1976 National Medal of Science by President Jimmy Carter at the White House on November 22. The citation was "for original research and advancement of knowledge of the physical and mechanical metallurgy of iron and steel, and especially for his work on the martensitic transformation in the hardening of steel." But Professor Cohen is at least as well known to most metallurgists for his work on materials policy and for his unified view under which the profession of metallurgy has been transformed into the field of materials science and engineering. (Photo: Wide World)

Corporate Leadership Awards

M.I.T. Corporate Leadership Awards have been conferred on a new "class" of alumni who now hold top management responsibilities for major business and industrial organizations in the U.S. The Awards were inaugurated in 1975, when 152 alumni/executives were honored by the Corporation. Now silver bowls "for distinguished corporate leadership" have been given to 16 newly qualified M.I.T. graduates:

☐ **J. Harold Bragg,** Chairman and Chief Executive Officer of Winnebago Industries, Inc. (Mr. Bragg studied in the Sloan School as a member of the Program for Senior Executives in 1967.)

☐ **Curtis D. Buford,** '42, President of Trailer Train Co.

☐ **John J. Casey, Jr.,** '40, Vice Chairman and Group Vice President of Braniff International.

☐ **Colby H. Chandler,** S.M. '63, President of Eastman Kodak Co.

☐ **J. Carl Clamp, Jr.,** '49, President of U.S. Filter Corp.

☐ **Samuel J. Davy,** S.M. '58, President, Treasurer, Chief Operating Officer, and Chief Financial Officer of Gladding Corp.

☐ **John A. Fanning,** S.M. '65, President and Chief Operating Officer of the Western Co. of North America.

☐ **William Friedman, Jr.,** '55, President and Chief Administrative Officer of Yonker Brothers, Inc.

☐ **William R. Jackson, Sr.,** '30, Chairman of the Board of Pittsburgh-Des Moines Steel Co.

☐ **Stephen J. Jatras,** S.M. '52, President of the Telex Corp.

☐ **H. Richard Johnson,** Ph.D. '52, President of the Watkins-Johnson Co.

☐ **Charles F. Kennedy,** '36, Chairman and Chief Executive Officer of the New York State Electric and Gas Corp.

☐ **John F. Magee,** '51, President and Chief Executive Officer of Arthur D. Little, Inc.

☐ **Robert Stuart,** Chairman of the Board of National Can Corp. (Mr. Stuart was a member of the Program for Senior Executives in 1959.)

☐ **Karl R. Van Tassel,** '25, President, Chief Executive Officer, and Director of A.B. Dick Co.

☐ **Robert E. Scifres,** S.M. '50, Chairman of the Board of National Gypsum Co.

Individuals Noteworthy

Honors at M.I.T.

Weston J. Burner, Director of Information Processing Services, has begun a two-year term on the Board of Trustees of the Interuniversity Communications Council, Inc., a consortium of educational institutions formed to help its members make best use of computer and communications technology. . . . **Wesley J. Harris,** Associate Professor of Aeronautics and Astronautics and of Ocean Engineering, is on the technical program committee for the American Helicopter Society's conference on helicopter noise control, schedule for May. . . . Six M.I.T. scientists are among 208 U.S. candidates for participation as mission specialists in flights of N.A.S.A.'s space shuttle; they now face a final selection process at the Johnson Space Center in Houston: **Ayre R. Ephrath,** S.M. '72, of the Center for Space Research Man-Vehicle Laboratory; **Michael J. Frankston,** '71, a graduate student in the Department of Earth and Planetary Science; **Alan M. Goldberg,** '69, a graduate student in the Department of Earth and Planetary Science; **Lionel O. Greene** of the Man-Vehicle Laboratory; **Jeffrey Hoffman** of the Center for Space Research; and **Byron K. Lichtenberg,** a graduate student in biomedical engineering.

Kudos: Honors, Awards, Citations

To **Arthur C. Ruge,** '33, Chairman of the Board of M.K.S. Instruments, Inc., Burlington, Mass., the Albert F. Sperry Medal Award of the Instrument Society of America — a certificate, medal, and $1,000 honorarium — for technical, educational, or philosophical contributions to the science and technology on instrumentation . . . To **Sidney L. Smith,** '47, the Jack A. Kraft Memorial Award, given by the Human Factors Society to recognize "significant efforts to extend or diversify the application of

human factors principles and methods to new areas of endeavor."

Counselors: Officers, Directors, Advisors

Arthur J. Renz, '48, head of Wheelabrator-Frye, Inc., elected a trustee of the Dartmouth Savings Bank, Hanover, N.H. . . . **Lewis W. Flagg III,** '69, named Manager of Systems and Procedures for the Chicago Regional Transit Authority . . . **William J. Cavanaugh,** '51, an acoustical consultant in Natick, Mass., elected President of the National Council of Acoustical Consultants.

Herbert S. Waxman, '58, Deputy Chairman of the Department of Medicine of the Temple University School of Medicine, and Chief of the Medical Service of the Temple University Hospital, named Chairman of the Department of Medicine of Baystate Medical Center, Springfield, Mass. . . . **Robert C. Lummis,** S.M. '58, Associate Professor of Neuroscience at Albert Einstein College of Medicine, named Director of Scientific Computing for the medical school and its parent institution, Yeshiva University.

Rising and Changing in the World of Business

Rufus E. Lester, Jr., S.M. '56, former Commander of the Army Natick Research and Development Command, appointed Vice President for Technical Affairs of the Stop and Shop Companies, Inc. . . . **Edward R. Adelson,** '50, formerly Director of International Programs for Martin Marietta Aerospace, Orlando, Fla., elected Vice President of Operations of Aeronautical Radio, Inc. . . . **Dennis J. Carney,** Sc.D. '49, President and Chief Operating Officer of Wheeling-Pittsburgh Steel Corp., named Chief Executive Officer there . . . **Lawrence Seligman,** '64, appointed Director of small business systems development for Data General Corp., Westboro, Mass.

Walter R. Niessen, '60, promoted from Director of quality and hazardous waste management to Vice President of the Industrial Engineering Division, at Camp Dresser & McKee, Inc., Boston . . . **Donald W. Coakley,** '52, promoted from Division Controller to Vice President-Controller of United Technologies' Hamilton Standard division, Windsor Locks, Conn. . . . **John Harkness,** S.M. '64, formerly Manufacturing Manager of Harvey Hubbell, Inc., Industrial Controls division, named Vice President and General Manager of Hubbell's Plastics division . . . **Wensley Barker, Jr.,** '40, joining Altair, Inc., as Regional Products Manager.

B. James Lowe, N.E. '58, formerly Manager of oceanic programs at Western Electric Corporation, Annapolis, Md., appointed Vice President of Quality Control of the Naval Products Division of United Nuclear Corporation, Montville, Conn. . . . **Philip R. Marsilius,** S.M. '48, formerly Executive Vice President of the Producto Machine Company, Bridgeport, Conn., named President of the company.

Christopher Goetze, 1939-1977

Christopher Goetze, Associate Professor of Geology who first came to M.I.T. as a post-doctoral fellow in 1969, died after a short illness on November 21, 1977. He was 38.

Professor Goetze, who was regarded by his colleagues in the Department of Earth and Planetary Science as a brilliant experimentalist in the field of the physics of rock deformation, was appointed to the faculty in 1971 and became Associate Professor in 1976. He held degrees in physics (A.B. 1961) and geophysics (Ph.D. 1969) from Harvard.

C. Warren Smalzel, 1919-1977

C. Warren Smalzel, S.M. '45, who was Institute Secretary for Corporations from 1964 until his retirement in 1976, died at his home in Cohasset, Mass., on November 23. He was 58.

Mr. Smalzel studied naval construction and engineering at M.I.T. following graduation from the U.S. Naval Academy (B.S. 1940), and he was on active duty in the Navy from 1940 to 1960; he rose to the rank of Captain and, before retirement, had been Head of the Bureau of Ships' Applied Sciences Division. At M.I.T. he had responsibility for development activities with corporations throughout the U.S.; before coming to the Institute he was associated briefly with Cabot, Cabot and Forbes as Executive Vice President and with Mill Associates of New Haven, Conn., as General Manager.

Deceased

Chauncey P. Manning, '02; November 26, 1977; 407 Foulk Rd., Wilmington, Del.
Robert J. King, '03; October 30, 1977; Box 456, New Canaan, Conn.
John M. Gray, '10; November 21, 1977; 3 Larchmont Rd., Salem, Mass.
Robert C. Stobert, '12; September 6, 1977; 2716 Southwood Rd., Birmingham, Ala.
Arthur E. Hirst, '13; September 19, 1977; P.O. Box 83, Swansea, Mass.
Malcolm Lewis, '13; 1972; 1002 W. Trinity Ave, Durham, N.C.
Kenneth A. Scott, '13; August 1, 1977; R.R.2, Box 50, Ethelsville, Ala.
E. Mortimer Newlin, '14; September 1, 1977; 298 S. Aberdeen Ave., Wayne, Penn.
Stanley M. Baxter, '15, 1970.
Everett R. Brigham, '15; November 9, 1977; 96 Loyola Dr., Ormond Beach, Fla.
Richard G. Berger, '16; May 15, 1977; 1928 North Ave., Bridgeport, Conn.
Edward G. Moody, '19; January 8, 1977; R. D. #3, 29 Hazel St., Nashua, N.H.
William T. Honiss, '20; November 21, 1977; 272 Key Palm Rd., Boca Raton, Fla.
Robert W. Tirrell, '20; August 10, 1977; 90 Bank St., Lebanon, N.H.
William A. Collins, '21; January 17, 1977; 12 Linfield St., Holbrook, Mass.
Hyman J. Levensohn, '21; September 28, 1977; 14 Temple St., Framingham, Mass.
William R. McKeen, '21; June 28, 1977; 75

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William T. Horlick, '22; September 20, 1977; La Mer, Apt. 606, 1904 So. Ocean Dr., Hallandale, Fla.
Lester C. Lewis, '22; July 25, 1977; 1661 Crescent Pl., Apt. 310, Washington, D.C.
Paul A. Blackwell, '23; October 11, 1975; 152 Mariner St., Buffalo, N.Y.
Horace W. Briggs, '23; December 6, 1976; Box 111, Fryeburg, Maine.

John P. Crabb, '23; November 4, 1977; 2800 E. Northern Pkwy., Baltimore, Md.
W. Gordon Hughes, '23; November 30, 1977; Nochols House, 184 Main St., Fairhaven, Mass.
Hugh H. Spencer, '23; December 10, 1977; 150 S. Spring Mill Rd, Villanova, Penn.
John H. Zimmerman, '23; May 20, 1976; 79 Henrys Rd., Brewster, Mass.
Jane M. Dewey, '25; September 19, 1976; 3600 N. Roosevelt Blvd., Key West, Fla.
Alexander W. Makepeace, '25; September 9, 1976; 2651 46th Ave., San Francisco, Calif.
John R. Oakley, '26; August, 1977; 1718 Tanglewood Dr., Akron, Ohio.
John W. Sanborn, '26; November 25, 1977; 82 Alpine Knoll, Fairport, N.Y.
G. Donald Buckner, '28; January 5, 1977; 9 Sands Ln., Port Jefferson, N.Y.
Raymond A. Jack, '28; September 21, 1977; 565 North Fifth St., Wood River, Ill.
Thomas L. Reid, '28; September 30, 1974; 242 Falconer Ave., Brockton, Mass.
Charles H. Lutz, '30; May 21, 1977; 5128 New York Ave., La Crescenta, Calif.
Burdette H. Buckingham, '31; November 4, 1977; 211 E. Melbourne Ave., Silver Spring, Md.
Louis S. Morse, Jr., '31; December 10, 1975; 1018 Stratford Ln., Bloomfield, Mich.
John R. Vincent, '31; 1975; 1061 Hemlock Dr., Blue Bell, Penn.
Alva T. Wilson, '32; October 12, 1977; Rt. 1, Box 86-A, Burnsville, N.C.
Fred L. Brugger, '33; August 20, 1977; 399 Putnam Ave., Cambridge, Mass.

Gerald V. O'Connor, '33; June 4, 1976; 680 Boulevard, Revere, Mass.
Theodore B. Hackpole, '34; January 6, 1977; P.O. Box 217, Hazelwood, N.C.
Charles F. Goodale, '35; December 15, 1977; 187 Crystal Lake, Box 488, Osterville, Mass.
Harry C. Kelly, '36; February 2, 1976; 613 Macon Pl., Raleigh, N.C.
Harold W. Davis, '38; October 29, 1977; Old Oaken Bucket Rd., at Cross St., Norwell, Mass.
Francis W. Hagerty, '38; December 7, 1977; Atlantic Ave., Cohasset, Mass.
Harry B. Hollander, '38; April, 1977; P.O. Box 262, Truro, Mass.
Severino J. Rugo, '38; October 12, 1977; 36 Burr Rd., Hingham, Mass.
William S. L. Christensen, '42; November 10, 1977; P.O. Box 103, Winona, Minn.
Wallace P. Dunlap, '44; May 19, 1977; 35 Hill Dr., Kirkwood, Mo.
Charles F. Lenhard, '44; November 24, 1977; Ilikon Corp., 7700 W. 79th St., Bridgeview, Ill.
C. Warren Smalzel, '45; November 23, 1977; 39 Atlantic Ave., Cohasset, Mass.
Robert M. Carbee, '48; January 24, 1977; 33 Robbins Ave., Amityville, N.Y.
Wendell J. Bridges, '65; October 30, 1977; 8640 Green Brass So. Dr., Indianapolis, Ind.
Norman Eaton, '69; October, 1977; 47 Sherburn Cir., Weston, Mass.
John P. Kimball, '70; December 2, 1977; 531 S. W. 26th Pl., Gainesville, Fla.
Walter E. Lewis, '72; June 19, 1977; 21 Amy Way, Red Bank, N.J.

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Costing Out the Sun

What can be said about the cost of solar systems to heat domestic water and the insides of homes and other buildings? The answer depends on each specific situation, which must be carefully examined to select the most economically advantageous of the many possible variations.

Heating domestic hot water with solar energy is an attractive option for both retrofitted and new applications, because the investment brings benefits all year long. For about $3,000 one could install a solar domestic hot water system able to supply 75 to 80 per cent of a typical annual need averaging 100 gallons per day. Such a system would use four or five 3-by-8-ft. flat-plate collectors and would heat as much water annually as about $300 worth of electricity priced at 5 cents per kilowatt-hour. Based on this rate of savings — sure to grow as electric rates rise — the installation would pay for itself in about ten years. If one took a mortgage that covered this investment, there would be an immediate savings because of the tax benefits.

Whether retrofitting a solar space heating system to an existing home or building a new solar-heated home, certain preliminary conditions must be satisfied.

☐ The angle that the roof pitch makes with the horizontal is equal ideally to the latitude plus 15° for space heating applications and to latitude alone for domestic hot water heating. However, a variation of ±10° makes little difference in efficiency.

☐ The roof slant must face more or less south, although a variation of ±20° from true south would make very little difference in energy collection. If the roof on an existing house was not acceptably oriented, one might have to install the solar collectors on a rack on the ground or, if available, on a flat area on the existing roof.

☐ Shading of the roof should be avoided. The site should be carefully analyzed for shadows during the peak collection hours, from 9 A.M. to 3 P.M., and the problems eliminated as completely as possible. Offending trees should be cut down whenever feasible, and one should attempt to make a formal agreement with a neighbor to pay for the topping of interfering trees and, possibly, for their replacement with smaller species.

☐ An investigation of the zoning of land to the south should be made to determine if a multiple-family dwelling, factory, office, or other tall structure could ever be built there.

Assuming these four basic conditions have been satisfactorily dealt with, the prospective solar-heated house — new and old — must be well insulated. My own house has R-11 insulation (3½ inches of Fiberglas) in the walls and R-19 insulation (6 inches of Fiberglas) both in the attic floor and between the rafters. All windows are double-glazed, and all openings are well caulked or weather-stripped. In addition, the basement walls are clad with R-8 insulation (2 inches of semirigid Fiberglas), and the house is completely vinyl-sided. This amount of insulation is no more than any house should have today.

A solar-heated house must have sufficient heat storage capacity to carry it through overcast days and cold nights. A 2,000-gallon storage tank can hold enough solar-heated water (at 140° F) for a day's supply of heat during winter.

Once an acceptably sited and insulated home is provided with a storage pool, the necessary collector panels, plumbing, and pumping apparatus must be installed. Meeting 65 to 70 per cent of the heating requirements of a home having 2,000 square feet of living space will require a minimum of 500 square feet of efficient collector panels in an area of high fuel demand. The installation of a suitable hot water heat exchanger in the storage pool would enable these panels to supply also 65 to 75 per cent of the energy for domestic hot water needs. Such a combined system, costing about $10,000, would yield as much heat energy annually as would $900 worth of electricity. On this basis in an electrically-heated home it would pay for itself in about 11 years.

In spite of recent rises in the price of No. 2 fuel oil, the cost of using it for heating is only about 40 per cent that of electricity. Thus, a $10,000 solar heating system of 65 to 70 per cent efficiency would save only about $360 of fuel oil annually. If oil for space heat is used in conjunction with electricity for hot water, the savings would be about $600. Thus, at current fossil fuel prices, the payback period is 20 to 30 years. So I conclude that, lacking a federal income tax credit — or other substantial subsidy — for solar installations, solar space heating is not cost-competitive with fuel oil systems.

One important point: all projections of return on solar investment assume that the systems will not deteriorate and will need little or no maintenance. Only time will separate the better from the worse systems. — *M.H., Jr.*

would have required 6,776 kilowatt-hours if it had been all heated by electricity. Thus, the saving was 5,872 kilowatt-hours, worth $294, or 87 per cent of the total hot water energy requirement.

Economics: Not Yet Compelling

The solar system worked smoothly during the first winter we lived with it. Performance turned out to be approximately as expected. The house was very comfortable, except for a few mornings when it took a while for the temperature to rise from a nighttime low of 60° F to a daytime normal of 68° F. I am planning to install some additional auxiliary heating capacity to overcome this problem.

As it turns out, based on last winter's performance and net energy savings at current prices, the payback period for my system is about 30 years. Currently, an economic optimum might be struck with a 65 to 70 per cent solar heat contribution, and the payback period could then decrease to about 20 to 25 years.

My experience thus suggests that the economics are not yet compelling; for widespread acceptance, solar systems require some government subsidy. Nevertheless, with the inevitable rise in fossil fuel prices, the shift to solar heating will accelerate.

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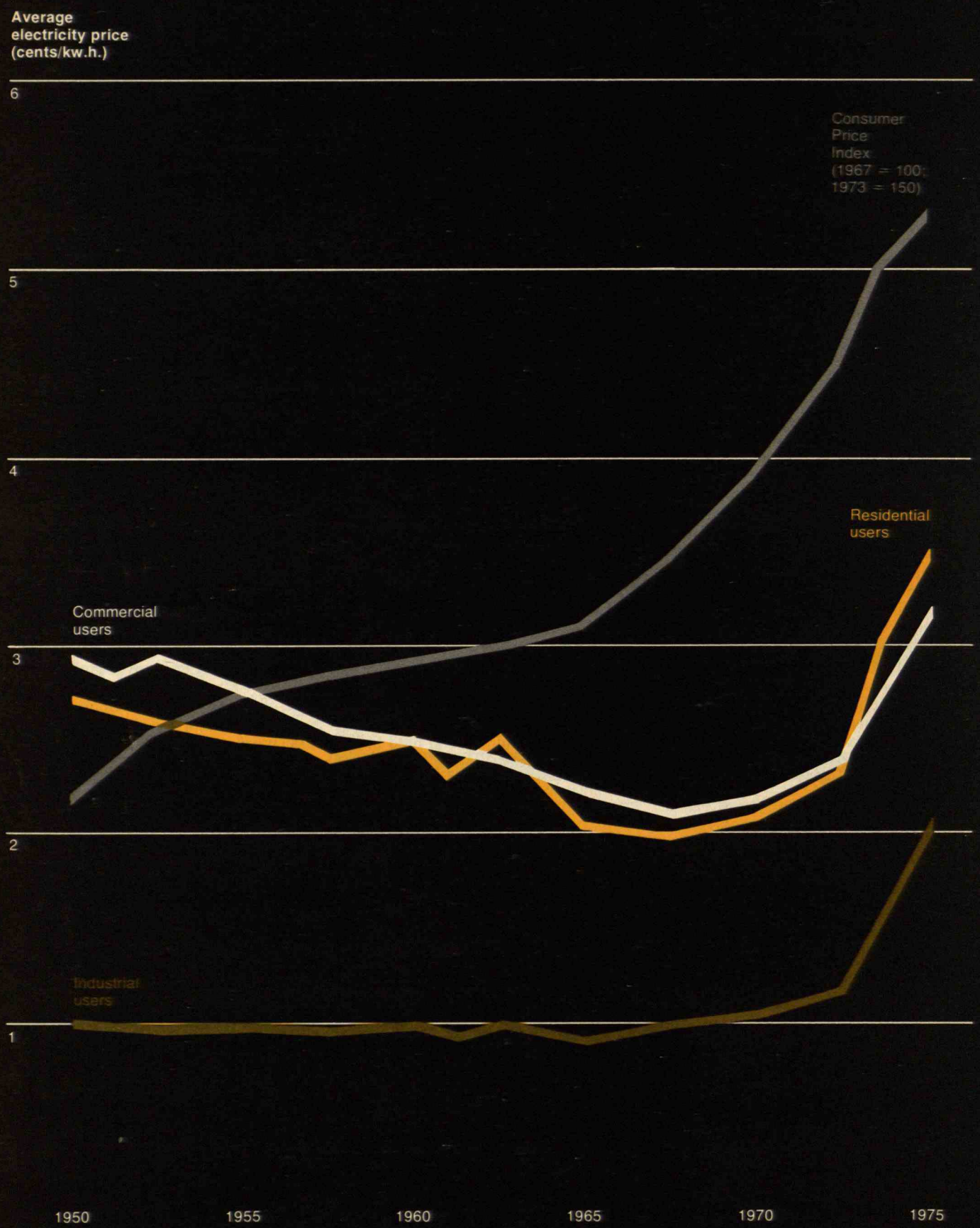
Average electricity price (cents/kw.h.)
6
5
4
3
2
1
Consumer Price Index (1967 = 100; 1973 = 150)
Residential users
Commercial users
Industrial users
1950
1955
1960
1965
1970
1975

The Politics of Rate Reform

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Electricity rate reform is a hotly contested issue nationwide, with billions of dollars at stake. One solution — a uniform price for industry and homeowners — may not be as equitable as it seems.

In mathematics, science, and engineering, simplicity or "elegance" often characterizes the best solution to a problem. But in regulatory economics, the opposite is often the case. The problems of government regulation are not intractable, but their solutions must always address past decisions and practice. A scientist can simply dismiss a theory that has been proven wrong. A regulatory official, on the other hand, must work through behavioral changes and investment decisions that have resulted from regulations based on an incorrect or outdated theory. He must develop new regulatory policies that look as much to the past as to the present and future.

Nowhere is this fact more apparent than in the area of electricity rate structure regulation.

In November, 1976, Massachusetts voters defeated a referendum that would have provided a simple solution to the problem of how to price electricity. The referendum question would have created a "flat rate" — a uniform price per kilowatt hour (kw.h.) — which would be charged to all customers of electricity. The question, one of the most bitterly contested in recent years, pitted residential users against commercial and industrial users, large businesses against small businesses, and politicians against many of their constituents.

From 1925 to 1969, technological improvements and economies of scale caused the price of electricity to drop — despite rising prices for other commodities of two to three per cent a year. The most dramatic decrease occurred in the rates for residential customers, which reached a low of 2.21 cents in 1969. But the charge per kilowatt hour to large commercial and industrial users was lower still, and when electric rates began to rise, especially after the 1973 Arab oil embargo, homeowners began to lobby for a single flat rate for all customer classes.

Why did this simple solution cause such a furor? Why was the referendum defeated? Here are lessons for residents of other states, as well as for survivors of the battle in Massachusetts.

Electricity rate reform promises to be a recurrent issue in each of the 50 states. Presidential efforts to promulgate national standards for rate design have failed to make it through congressional committees, and so each state will have to set its own standards for reform and its own timetable for action. The Massachusetts debate may have been somewhat atypical in its intensity, but the issues and interest groups involved are common to all states. As electricity becomes a more expensive commodity, these issues and interest groups are certain to burst forth in other states.

A Unique Commodity

Every issue concerning the production and sale of electricity is influenced by one important fact: the production of electricity must be concurrent with its consumption. In this sense, electricity is a unique commodity. Unlike automobiles, fuel oil, canned peas, and T-shirts, substantial quantities of electricity cannot be produced by manufacturers and stored for later sale. Electric companies have no inventory of electricity. Instead, they must maintain sufficient generating capacity to serve without interruption their customers' fluctuating demands for power.

Facilities are kept in reserve to be brought on line when demand warrants. (In New England, the amount of power produced is adjusted to meet the level of customer demand every 12 seconds by a regional computerized dispatch center in West Springfield, Mass.) This balancing operation — matching supply and demand — occurs virtually every instant throughout the year.

The implications of this characteristic of electric power production are immense. Enough generating capacity must be built to serve the maximum coincident power demand — the "peak load" — on a utility's system. In New England, a "winter peaking" system, the peak load generally occurs late in the afternoon on a cold winter day, often just before Christmas. On this day, at about six o'clock in the afternoon, office buildings are illuminated, children are home playing under electric lights (often with electric toys), dinners are being cooked on electric ranges, outdoor seasonal decorations are lit, department stores are open for last-minute shopping, electric-powered transit systems are suffering through the rush hour, street lights are on, and heating systems are operating. Tremendous demands for power from a variety of customers all come at once. (The winter peak in New England in 1976 was 14,739 megawatts [mw.], 1.67 times the average demand for the year.)

Other utilities (including some electric companies within New England, such as Boston Edison) are "summer-peaking" companies. That is, their peak load is usually recorded in the summer and reflects a large seasonal use of air conditioning. The situation for a summer-peaking company is worsened by their lower effective generating capacity during hot weather. (Gas turbines, for example, are air-cooled.) Thus, in order to supply the same amount of power demanded of a winter-peaking company, a summer-peaking company must have about 5 per cent more generating capacity.

But for both summer- and winter-peaking companies, there must be sufficient generating capacity to serve the customers' largest coincident demand.

A Delicate Balance

Because it makes more sense for one electric company to service a given geographic area than for two or more companies to duplicate transmission and distribution equipment, the retail electric companies are assigned exclusive regional franchises. In return for granting these monopolies, the state has assumed responsibility for regulating the utilities to ensure that they will not abuse their monopoly power. The states' regulatory authority is generally vested in a quasi-judicial agency: a public utility commission (P.U.C.), public service commission (P.S.C.), or — in Massachusetts — the Department of Public Utilities (D.P.U.). This power of regulation is granted to the agency by the state legislature on behalf of the people.

The agency must protect the public from abuses of monopoly power, in particular the charging of unreasonably high electric rates. On the other hand, the P.U.C. is obliged by the Constitution to ensure that the property of the utilities and their investors is not confiscated by unfair regulation. Public hearings must be held to determine a reasonable profit or return on investment which the utilities are permitted to earn. So the P.U.C. must perform a delicate balancing act: it must protect the consumer by not letting electric rates rise too high, and it must protect the utility by allowing rates high enough to produce the revenue that will bring about a fair rate of return.

For every dollar the utility has invested in plant and equipment, it is entitled to earn a rate of return. We shall assume here that the rate is adequate. Thus, when a power plant is built to help the company meet its peak load, that plant enters the "rate base." The utility's customers must pay for the plant, plus a rate of return, even if it is used to meet peak demand only ten times a year.

Hence, because electricity cannot be stored, and because utilities are regulated monopolies, we find:

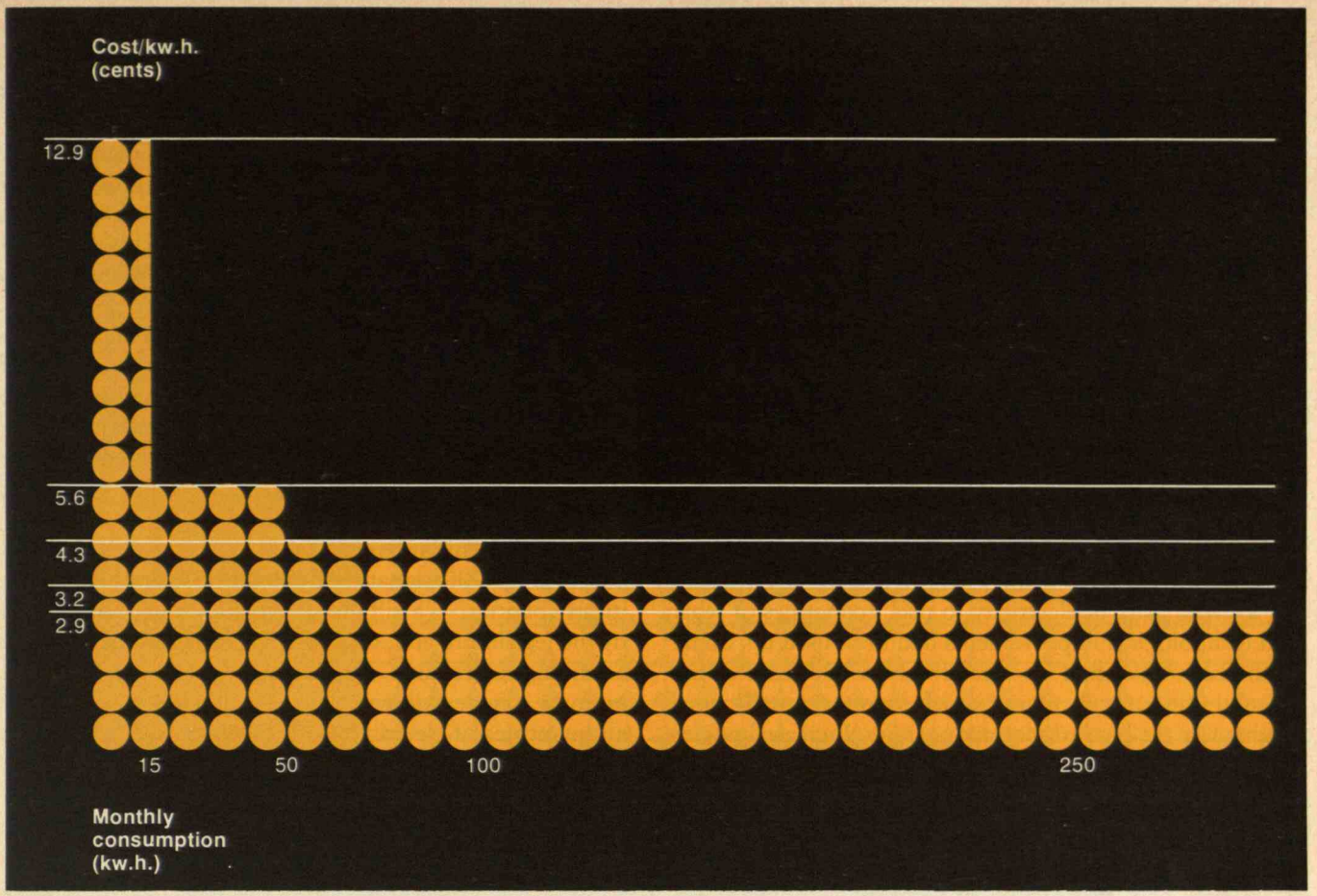
☐ There must always be enough generating capacity to serve the utility's peak load.

☐ The power plants built to serve the peak load will be charged off via the electric rates to the customers of the utility.

Now add one more complication. Different types of customers use electricity in different ways. A homeowner will use about 5 kw. of power during peak usage (dinnertime, with the heating, lights, and television on), but a homeowner's average demand will be about 0.55 kw., with a monthly energy consumption of about 400 kw.h. (Power multiplied by time equals energy; thus [0.55 kw.] × [720 hours/month] = 400 kw.h.) A large industry, on the other hand, may have a peak demand of 9,000 kw., an average demand of 5,000 kw., and a monthly energy consumption of 3.6 million kw.h. And the peak demands of both the homeowner and the industry may or may not coincide with one another or with the peak load of the utility itself.

Given such differences, should the rate scheme be different for the homeowner and the industry, or should it be the same? Should these customers pay electric rates based on the amount of power they demand — either the maximum, the average, or both? Or should the homeowner and industry pay rates related to the utility's peak load rather than to their individual use? Or should both the utility's peak load burden and individual demand determine the rate in some combination? Should a customer who uses power during the utility's peak period pay more, even though that customer has no choice in the matter of when to use power? Should rates be skewed to help industry at the expense of the homeowner, or vice versa, or neither? If the homeowner is poor and elderly, should a special rate be available since electricity is a necessity of life? If an industrial customer is competing with a firm in the Pacific Northwest which can buy electrical energy at one-fifth the cost, should the industry be offered a discount so that it can gain a competitive advantage and provide jobs for the home state?

These questions serve to underline the key issue. Given a stock of power plants and related equipment to serve a certain power load, and given that rates will be charged to recover the cost of this equipment, what pricing mechanism should be used to ensure that different types of customers pay their fair share?



A typical declining block rate structure. The high cost for the first 15 kilowatt hours would be included in a minimum monthly bill of $1.94, covering a large percentage of the fixed costs of serving a customer (meter, distribution lines, meter reading, and billing). The fixed costs remaining are "hidden" in the following blocks. The last block — monthly consumption of 250 kilowatt hours or more — adds only the utility company's variable cost (e.g. fuel) to produce an additional kilowatt hour. Because the cost per kilowatt hour decreases as demand increases in this rate structure, consumption of electricity is encouraged. The customer finds that each kilowatt hour is cheaper than the last. In contrast, an alternative scheme charges each customer a monthly service fee plus a uniform price for each unit of electricity consumed, whether 15 kilowatt hours or 250 or more.

Rate Structures: An Inexact Science

We encounter rate structures every day. The quantity discount is one example. Lettuce is 35 cents a head, or three for a dollar. The airfare from Boston to New York is $37, from New York to Washington, D.C., $40, and from Boston to Washington, D.C., $59.

For years, the price of electricity has also incorporated quantity discounts. The most common rate scheme in the U.S. today is the "declining block" structure, a scheme by which the price of electricity per kilowatt hour drops at certain points of greater consumption (*see figure, above*). Thus the average price per kilowatt hour drops as consumption increases. Equally important, the marginal cost per kilowatt hour — the cost of an incremental unit of electricity — also falls at various points in the rate structure.

The declining block rate structure is also used in determining the price of electric power as opposed to energy. Here the average and marginal costs per kilowatt of power demanded fall at various intervals in the rate structure. (The maximum demand in any 15-minute period generally determines the rate paid.)

Residential users pay for electricity according to their kilowatt-hour usage, whereas commercial and industrial rates are generally composites of a company's kilowatt-hour usage and its power demand. (This is because demand meters are more expensive than energy meters and are considered warranted only for large customers.) An additional feature is often included in commercial and industrial rates. When a given level of power is demanded for longer than 100 or 200 hours a month, a discount is applied to the energy consumed. This "rewards" the customer for having a better "load factor" — a more evenly spaced power demand.

The declining block rate is subject to much scrutiny and complaint today; it is an outdated and inappropriate rate structure. The scheme was appropriate during the many years when the electricity business was a "decreasing cost" industry. Because of efficiencies of production and technological improvements, every time a new power plant was built, the average cost of producing electricity would fall. The new, larger, more efficient plants could generate electricity at lower cost than their predecessors. Thus the more power plants built, the lower the average cost of electricity. So a rate schedule that used quantity discounts to encourage consumption made economic sense.

For years, this scheme worked well. For example, be-

tween 1940 and 1970, the average household consumption in New England increased from 67 kilowatts to 457 kilowatts per month. Meanwhile, the average cost per kilowatt hour fell from 4.65 to 2.59 cents. A similar pattern has occurred throughout the country, as the figure on page 36 shows. The quantity discount paid off for the consumer in cheaper energy and power. The utility benefitted as well because the rate base on which it would be allowed to earn a percentage was increasing. The combination of a growth industry having happy stockholders and happy customers was similar to the heyday of the automobile industry after Henry Ford perfected mass production. The regulatory agencies were in the enviable position of occasionally approving rate decreases.

The dream could not last. In the late 1960s, the utilities entered a new era: costs no longer diminished as demand increased. Environmental and safety requirements, as well as rapidly inflating labor, materials, and engineering costs meant that every new plant built now would cause the average price of electricity to rise. Economies of scale and technological improvements had been used up. Some of the economies had also resulted from increases in the thermal efficiency of plants which were eventually constrained by the laws of thermodynamics. Increased power production now meant higher rates instead of lower rates. Suddenly stockholders and customers had divergent goals. It was still to the utility's advantage to build plants and expand its rate base, but it was to the customers' disadvantage. The declining block rate remained in use, encouraging consumption and the need for more power plants. But now the dividends from new construction entered the stockholder's hand by way of the customer's wallet.

Meanwhile, the regulatory agencies had grown complacent from years of inactivity and requests for rate decreases and failed to respond to this important change. In all fairness, it should be noted that customers did not complain very loudly. After years of declines, the rate increases seemed mild and the cost of electricity in constant dollars, considered over a ten-year period, had barely changed. It took an outside force to stir things up.

The Winter of Our Discontent

During the last months of 1973, the Organization of Petroleum Exporting Countries (O.P.E.C.) tripled the price of crude oil. Utilities in Massachusetts at the time imported 92 per cent of their oil. The immediate impact of the O.P.E.C. increase was a tremendous, swift jump in the fuel adjustment charge on people's electric bills. (The fuel adjustment charge is an automatic indicator of utility fuel costs.) Boston Edison customers paid a 396 per cent increase in fuel charges between September, 1973, and July, 1974. A family using the average 400 kilowatt hours per month paid a 36 per cent increase in their electric bills. In other states, the impact of the higher oil prices on consumers' electric bills was also dramatic, if not so severe.

Following a great furor, Massachusetts residents became interested in the rest of the rate structure as well — the part that reflects the cost of plant and equipment, operating costs, and rate of return, subject to control of the state, not the oil cartel. Consumer groups formed during the fuel adjustment debate in 1974 now turned their attention to the "base rate." Residential consumer groups discovered that quantity discounts enabled large businesses to pay a significantly lower price per kilowatt hour. Small businesses allied with the residential groups when they learned that their average rate was also higher than that of the larger firms. The Governor and the Attorney General petitioned the D.P.U. to review the matter, and in October, 1974, a hearing on rate structures began. Meanwhile, legislation was submitted for the 1975 session to revise rate structures according to a multitude of schemes. By February, 1975, it was clear that the D.P.U. hearing was floundering amid procedural matters and the utilities' rate request hearings. It was also evident that the legislature would not vote to decide the issue, preferring to leave the question to the D.P.U.

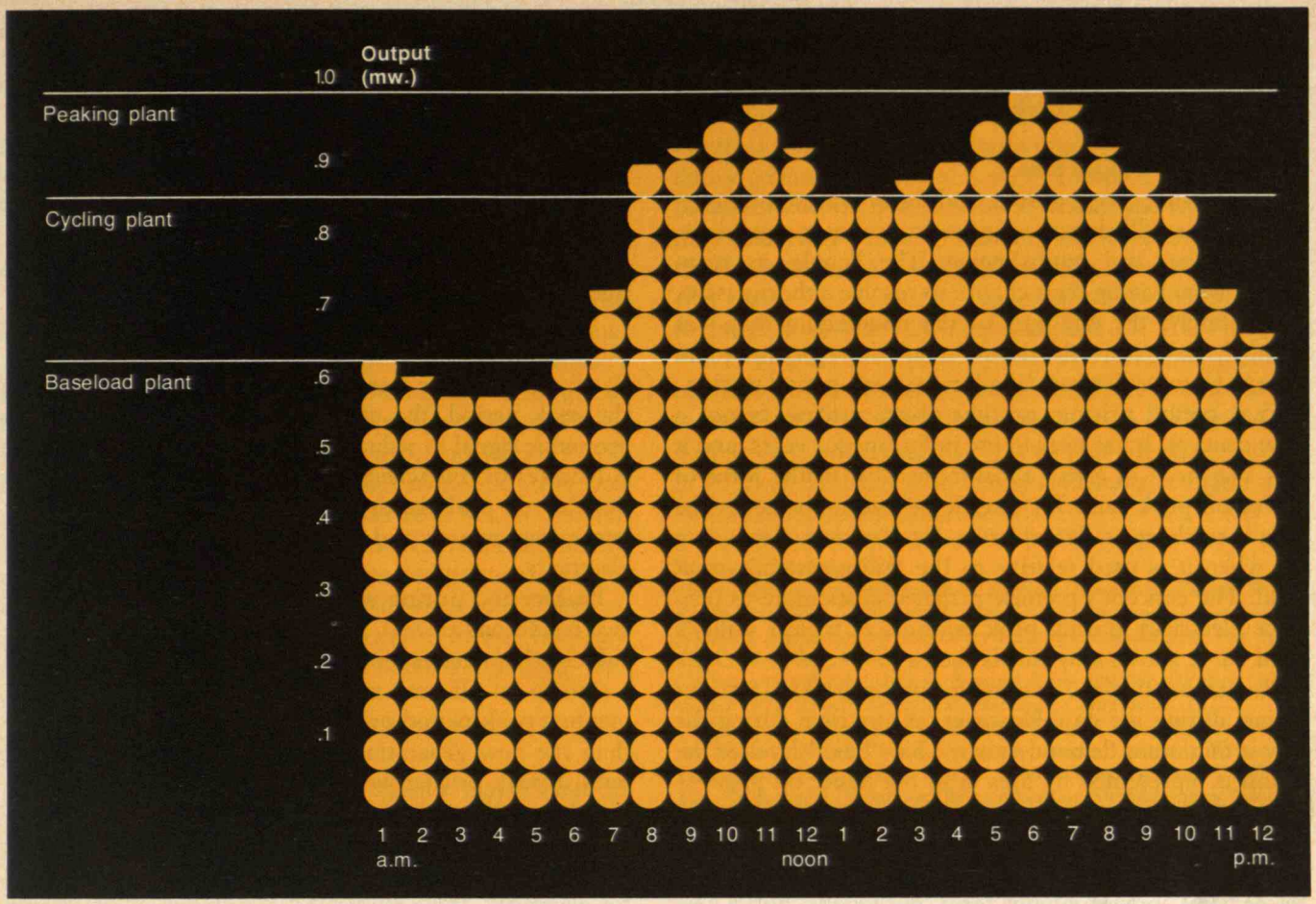
Faced with this apparent inactivity, a consumers' group collected 88,000 signatures, enough to introduce an initiative petition — a bill that would have to be voted upon by the legislature and, that failing, placed on the ballot as a binding referendum. The initiative petition called for a uniform rate per kilowatt hour for all customers and for all quantities of electricity sold. Among other provisions also included was a scheme to allow peak-period pricing, so that utilities could charge higher rates during their peak-load periods.

Lower Rate and Higher Prices

The initiative petition had two major purposes: to eliminate the declining block rate structure, and to introduce a flat rate per kilowatt hour. Without an incentive to use more electricity, people would conserve more energy and fewer power plants would be built and added to the rate base. The flat rate would reduce residential and small business electric rates. It would have resulted in a 22 per cent decrease in the average family's electric bill, or savings of $5 per month.

Many people who had criticized the declining block rate system favored flattening the rate structure, and from that point of view supported the referendum. A flat rate, it was argued, would encourage energy conservation and might help slow the growth in electric power demand. Yet many of these same people did not support the bill. A proposal that would lower electric bills for homeowners and small businesses would have to make other electric bills go up.

The shift in revenues resulting from the flat rate would be about $70 million per year (about 6 per cent of total electric revenues in the state). Electric bills for large industries and commercial establishments would rise an average 24 per cent. Hardest hit would be those firms with a high power demand and long operating hours, since the new law would prohibit the discounts for many hours' use of a steady level of power. Hospitals would face a 34 per cent increase; office buildings, 27 per cent; supermarkets, 24 per cent; colleges and universities, 33 per cent; manufacturing firms, 34 per cent. Obviously, businessmen did not want to face higher operating costs. But householders could also worry that savings in home elec-



Demand for electric power fluctuates throughout the day; above is a typical winter load pattern for a New England utility. Base-load plants (expensive to build but cheap to run) are kept in constant operation, providing more than 600 megawatts of energy apiece. As more electricity is required for heat and power, cycling plants (less expensive to build but costly to operate) are brought on line, each generating 150 to 400 megawatts. On a few cold days during the year, still more power will be demanded, usually around noon, and peaking plants (15 to 100 megawatt capacity) must be started up to supply it. Peaking plants are cheap to build and very expensive to operate. Thus the cost of electricity per kilowatt hour is lower when only base-load plants are required than when cycling or peaking plants must operate. A peak-period pricing scheme would charge rates that vary with time of demand. The plan could encourage consumers to reduce demand during peak-periods and thus to hold down the generating costs that would otherwise be reflected in their monthly bills.

tric bills would be counterbalanced by increases in the cost of goods, services, and taxes. Would the price of such necessaries as food be increased to reflect the higher cost of electricity? Low- and moderate-income families spend a relatively large share of their income on such necessities and would thus receive an indirect, repressive tax. Others feared increases in direct taxes. State government, for instance, would be paying $2,800,000 more per year for electricity. Cities and towns would also face increases. Obviously, these costs would be paid by the taxpayers. Finally, industrialists and labor unions worried that Massachusetts firms, facing competition from businesses in other parts of the country, would close or restrict operations and new companies would choose not to locate in the state. New Hampshire had already used its lower taxes to "steal" 60 Massachusetts firms in the past year. People did not want to give the Granite State even more ammunition against the Commonwealth.

The basic problem with the flat rate proposal was its attempt to shift costs for electricity from one customer class to another. Thus, while homeowners would benefit, businesses would be hurt. Other alternatives for rate reform — making changes within customer classes — would not have encountered so much opposition, and could have achieved some of the same goals as the flat rate petition. For example, the fixed costs that constitute the major part of the early blocks in the declining block system might be separated out as a monthly service charge. Then the customer pays a flat rate per kilowatt hour consumed. The amount of the monthly service charge would vary between customer classes, reflecting, for example, the fact that many large firms purchase electricity at a higher voltage than residential users, and thus should not be charged for the cost of a local distribution system. The cost per kilowatt hour, though, would be the same for each customer class because, once the utility's fixed costs are accounted for, a kilowatt hour delivered to a factory costs the same as that delivered to a home.

These kinds of changes are possible, without shifting revenue from one class of customers to another, and they can bring about a good deal more energy conservation than results from the present system.

New Use for an Old Idea

The battle-lines were drawn, and the airwaves and newspapers were filled with arguments, counter-arguments, fact-slinging, and mud-slinging. The People, as regulators, were having their chance to resolve a thorny issue. Interestingly, the one part of the referendum that was virtually ignored in the debate would have permitted an exception to the flat rate by allowing peak-period pricing.

Peak-period pricing, or time-of-use pricing, is not a new concept. It has been in use in Europe for years, and it has also been in effect all over the U.S. in the form of lower off-peak rates for electric hot water heaters. The idea is to charge different prices for electricity depending on when it is used relative to the utility system's peak load. The concept's premise is that it costs more to produce electricity during peak periods. A typical utility's load curve shows why this is the case.

Remember that the demand for power peaks at various points during the day. However, at any time during the day a minimum demand exists. This "base" level of demand is represented by area A in the figure on page 41 (the figure denotes a winter load pattern, with the peak occurring in morning and early evening). Demand varies through the rest of the day, requiring a fluctuating, "intermediate" power supply (area B). Finally, for a few hours, demand peaks (area C). This load pattern determines what a utility will need to meet demand at different times.

Base-load plants (usually 400 mw. or larger) are expensive to build and cheap to operate. Thus base-load plants have large fixed costs and small variable costs. They are also difficult to turn "on" and "off," being designed for sustained operation. Utilities try to build enough base-load capacity to meet the day-long power demand.

Intermediate or cycling plants (150 to 400 mw.) have slightly lower capital costs than base-load facilities but are more expensive to operate. For example, a base-load, oil-fired power plant might have a heat rate of 9,900 B.t.u./kw.h., while an intermediate plant would have a heat rate of 10,700 B.t.u./kw.h., thereby requiring 8 per cent more oil to produce the same kilowatt hour. Cycling plants, as their name implies, are useful for meeting variable demand because they can be regulated within a matter of minutes.

Peaking plants have low capital costs and very high operating costs. They are built to operate only a few days per year for only a few hours at a time. A typical heat rate for a peaking unit is 14,000 B.t.u./kw.h., or 40 per cent greater than a base-load plant. Peaking units are built to meet the occasional peak demand on the utility system. Gas turbines (jet engines) are typically used for this job.

It is immediately obvious that it will cost more to produce a kilowatt hour during a peak period than during an off-peak period because the peaking and cycling units will use more fuel per kilowatt-hour than the base-load plants. Part of the theory of peak-period pricing is to charge different rates for electricity to reflect this variation in fuel consumption during different times of day. The rate system also reflects the fact that capital charges also vary during the day. For example, even though a gas turbine costs less to build per megawatt than a nuclear plant, if the turbine is only used 100 hours a year, its effective cost per useful megawatt is greater than that of the nuclear plant operating 8,000 hours a year.

No Sure Assumptions

By charging higher rates for electricity consumed during the peak period, the utilities would give customers an economic signal to reduce consumption during that time. Advocates of this scheme argue that in the long run, reduction of peak loads will reduce the need for new generating capacity and will help to keep down the cost of electricity.

Peak-period pricing will accomplish these ends only if two conditions are met. First, demand at the peak must be sufficiently price-responsive for higher costs to encourage a shift to an off-peak period. Second, the cost of implementing peak-period pricing to the utility must be lower than the new generating plants that would have to be built if peak pricing weren't introduced. Neither condition has yet been demonstrated conclusively.

But the basic data are lacking. While econometric studies have measured the price elasticity of the demand for electricity, these studies have centered on changes in overall consumption of electricity in response to price. Without data, statistical studies have not yet been able to measure time-of-day price responsiveness. Demand may or may not be flexible at peak periods, but without data we can make no sure assumptions.

A number of studies are presently underway to test the hypothesis that customers will change their consumption habits in the face of peak-period pricing. A utility in Connecticut, for example, has chosen a random sample of 1,000 homes to test a three-part (peak, off-peak, and "shoulder") rate schedule. Results in Connecticut are promising: homeowners did shift consumption away from the peak period. More such studies will be encouraged by the federal mandate in the Energy Conservation and Production Act of 1976. These experiments will provide vital information to public regulatory agencies and utility companies for use in designing rates.

Assuming positive results in these studies, one must still balance the costs of implementing peak-period pricing against its benefits. Will the lower demand encouraged by peak-period pricing yield more than enough revenue to cover the cost of time-of-day meters and related equipment? The answer is almost certainly positive when we consider a big commercial or industrial customer with a large potential to reduce peak demand. There the reduction in peak demand (say, 20 kw. at a saving to the utility of $150/kw.) will far exceed the cost of demand meters ($200). Load management equipment can help these large users shift power demand to off-peak periods. For a small residential user consuming 4 or 5 kw. at peak, the poten-

tial reduction in power demand might be very small. In this case, the cost of a time-of-day demand meter might exceed the benefits of lower demand.

Opinion is sufficiently favorable that peak-period pricing is likely to be phased in over time. Large consumers of power will be the first to be charged differential rates. Small users will be incorporated into the scheme as the cost of the peak-period metering equipment lowers or otherwise becomes economical.

Peak-period pricing has been accepted in theory by economists, utility companies, many regulatory commissions, and many consumer groups. The reason for such widespread support is probably that each interest group has its own conception of what peak-period pricing is, how it will work, whom it will help, and whom it will hurt. The theoretical concept makes economic sense, but most state regulatory commissions have yet to bite the bullet and transfer theory into practice. Although nearly everyone seems to approve peak-period pricing now, the consensus is certain to break down when rate schedules are filed and the monthly bills begin to arrive. Like any new cost-allocation scheme, peak-period pricing will make both friends and enemies.

Rates and Politics

Peak-period pricing might have been a major issue in Massachusetts. Yet it was glossed over because it was not perceived as a critical area of debate. In politics, perception is all.

Polls taken during the weeks leading up to the referendum indicated that there would be a very close vote on the flat rate question. Attendance at the polls was expected to be high because it was a presidential, congressional, and legislative election year and because six other binding referenda — ranging from gun control to the Equal Rights Amendment — were also on the ballot. On November 6, 82.4 per cent of Massachusetts voters turned out to vote. Flat rate was defeated 1,793,022 to 608,691, or 75 per cent to 25 per cent. Clearly the citizens of the state had chosen to continue to place regulation of public utilities in the hands of the state regulatory agency. The baton, having been passed to the legislature and thence to the people, was quickly shoved back to the D.P.U. in recognition of a very complicated issue.

Some argue that this was cowardice, or kow-towing to powerful business and labor interests. I believe it was an intelligent choice. The ballot booth is no place for rate-making. There is too much at stake for a "yes" or "no" vote in such matters. Legislation tends to overlook many of the subtleties inherent in public regulation, and today subtleties can be worth millions of dollars in resources. The public's decision to rely on the traditional regulatory framework was entirely appropriate.

The rate structure question remains an issue of public debate in the states and in Washington, D.C. Recent decisions by regulatory commissions in Massachusetts, Connecticut, Wisconsin, and elsewhere have adopted the principles of peak-period pricing, elimination of the declining block rate structure, and other reforms. Other states are also studying the issues. Decisions on pricing systems and rate structures will continue to be made over the coming months, and millions of dollars, investments in capital equipment, and changes in personal habits are at stake. Lack of data will complicate these decisions. Political and economic pressures may force the state regulatory commissions to act without complete information. However thorough the statistical studies and experiments now underway prove to be, they will be completed too late for many rate-making decisions pending in the next two years. Thus regulatory agencies will be forced to experiment with much of the population.

A clear sense of direction on the part of state regulatory officials will be essential if the entire process is not to go awry. The officials must be willing to take chances, make corrections, and try again. This will be public regulation at its most difficult. With strong leadership, it might also be public regulation at its best.

Suggested Readings

Electric Power Research Institute, Electric Utility Rate Design Study, *Rate Design and Load Control: Issues and Directions* (report to the National Association of Regulatory Utility Commissioners), Palo Alto, Calif., November, 1977.

Connecticut Public Utilities Control Authority, *Final Report, Connecticut Peak Load Pricing Test,* Hartford, Conn., May, 1977.

Massachusetts Department of Public Utilities, "Regulations Requ - ing Private Investor-Owned Electric Companies Operating Within the Commonwealth to Adopt Rate Structures Based on Peak Load and Time Differential Pricing and Related Costing Methodologies," docket number D.P.U. 18810, Boston, Mass., October 20, 1977.

Paul F. Levy was appointed Commissioner of the Department of Public Utilities for the Commonwealth of Massachusetts in January, 1978, following three years as Deputy Director of the state's Energy Policy Office. His undergraduate degrees in economics and urban studies and planning and his Master's degree in city planning are from M.I.T., 1974.

Food Security for the World's Poor

Lance Taylor
Alexander H. Sarris
Philip C. Abbott
M.I.T.

Laying in stores of food for hard times ahead is an ancient and honored public activity — at least as ancient as the biblical Joseph and his predecessors in the riverine civilizations of the Middle East. Most cultures still honor the activity in folk tales. We're all familiar with the story of the thrifty ant who demonstrates civic virtue, saving seeds for itself while leaving the frivolous grasshopper justly to starve.

Those who now make public policy were reared with this cultural background. So their current indecision about setting up grain reserves looks a bit surprising. Why wasn't a coordinated international food reserve system set up years (or centuries) ago? Outside of fairyland and the bible world in which Pharaoh's vizier *knew* that there would be seven bad years, of course, are many institutional, political, and economic obstacles against any attempt to further the public good by establishing food reserves.

A discussion of political economy cannot be avoided in this context: all governments intervene in grain markets to obtain more freedom in formulating internal agricultural and food consumption policies. Any negotiated agreement about an international food security scheme must accede to the fact that national rulers will continue to play a major role in assuring food supplies to their people.

The 1972 Food Crisis: Causes and Response

From before the Great Depression until 1972, food security was not a major issue on the world scale (though repeatedly at the level of famine-stricken regions and countries, it was of paramount importance). World grain markets were a haven of stability, with prices fluctuating a few percentage points per month, at most. But from late 1972 to early 1974 the situation changed drastically, as prices of major traded grains almost tripled. For example, the New Orleans export price of U.S. wheat went from $63.80 per metric ton in August, 1972, to $103.60 in December, 1972, and rose to an astonishing $221.60 the following February.

A number of factors led to these developments:

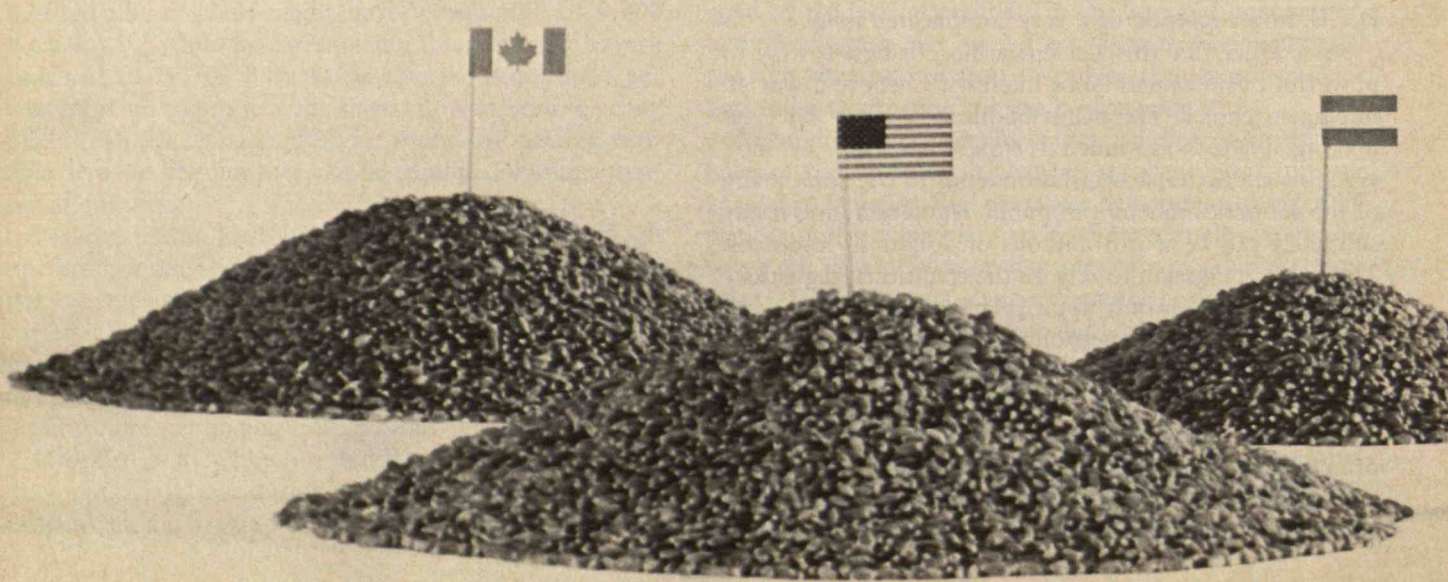
☐ A decline in world grain production in 1972-1973 was caused by unfavorable weather and acreage restrictions in major producing countries.

☐ The reduced Peruvian anchovy catch in 1972 led to increases in demand for soybean meal and ultimately to an increased demand for feedgrains.

☐ The Soviet Union purchased over 15 million tons of grain to make up in an unexpectedly vigorous way for production shortfalls in that country.

☐ The U.S. dollar was devalued.

Econometric analyses suggest that 60 to 80 per cent of the observed food price increases can be attributed to



All nations agree that an international reserve of food should be maintained to stabilize food prices and feed the hungry when famine strikes. Deciding how to do it — how much to save, what to pay, and where to store — is another matter.

these factors. The remaining inflation is best explained by a desire for "liquidity" in staples on the part of many governments that control their nations' grain trade. The Soviet purchases in 1972 exhausted U.S. and Canadian stocks. The knowledge that North America could no longer fulfill its historical role as a reliable residual grain supplier spread fast, causing panic buying among importers. Fears of food shortage persisted for some time, even though 1973-1974 was a record world crop year. And widespread dissatisfaction with the structure and functioning of the worldwide supply system led to the Rome World Food Conference in November, 1974.

The current discussion of grain reserves really began with the preparatory papers for that Conference. During the formal discussions, reserve schemes and food aid were viewed almost as panaceas. According to Resolution XVII, a reserve/aid combination should ". . . assure the availability at all times of adequate world supplies of basic foodstuffs, primarily cereals, so as to avoid acute food shortages in the event of widespread crop failures or natural disasters; sustain a steady expansion of production; and reduce fluctuations in production and prices."

Clearly, the Rome conferees envisaged a world food security agency that at the very least could transfer supplies so that everyone would "have enough," assure that unanticipated local supply shortfalls would be made good, and stabilize prices and production. We shall refer to these goals as "food aid," "emergency relief," and "stabilization" respectively. We deal with all three issues here, trying to understand their significance in terms of both political economy and magnitude.

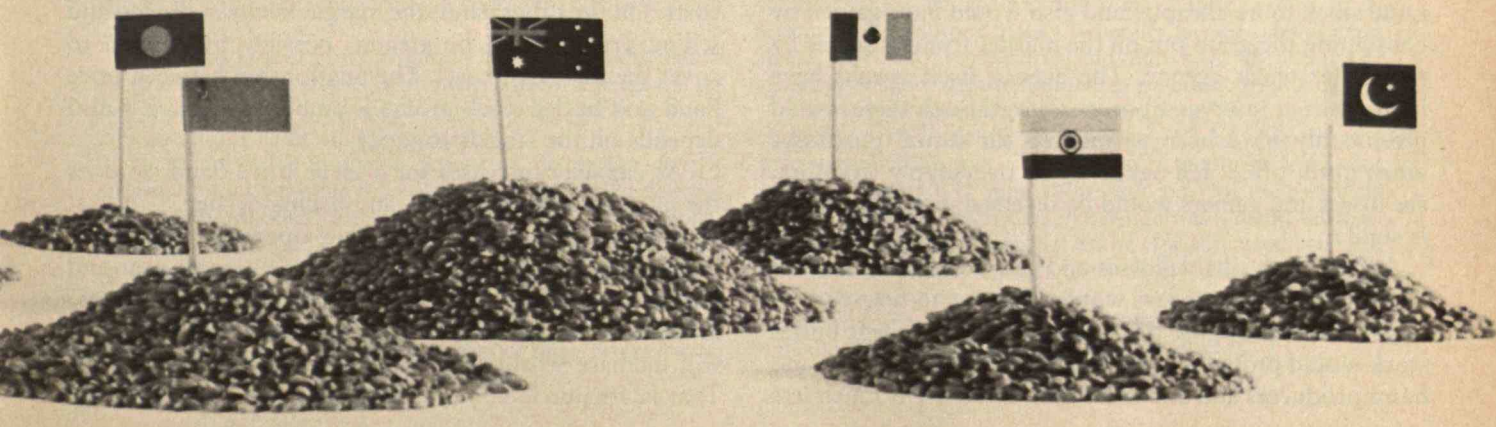
Market Stabilization Through Buffer Stocks

How can stabilization be attained, and how can we measure its benefits once achieved? When we address these questions, a number of conceptual problems arise:

☐ Should quantities or prices be stabilized? Price stabilization seems the more logical answer. Although the Rome conferees preferred to think in terms of quantity, this goal is unattainable in our uncertain world. A completely unprecedented crop shortfall could always occur in the next growing season, in such magnitude as not to be offset by any conceivable amount of food in storage.

The usual approach to such essential uncertainty is to set up the problem in probability terms — to design a reserve large enough to be sure that if historical crop fluctuation patterns persist, then world supply will not be more than (say) 30 million metric tons (mmt) short in (say) 99 years out of 100.

In the wake of the Rome conference, a number of calculations of this sort were carried out. Typically, these indicated that 25 or 30 million metric tons each of wheat and



feedgrains "ought to be" stored. The rationale is simple: the standard deviation of world production of either major class of grains has been about 12 to 15 mmt over the past 20 years. Having two standard deviations' worth of both crops in storage would allow the world to make up for bad harvests in all but the worst year or two in a century. Q.E.D.

The economist's problems with this approach are readily apparent. Unless those who manage the stores in a probability-based reserve scheme approach both omniscience and omnipotence in their responses (recall Joseph once again), the market will compensate for their mistakes via changing prices. Why not then *plan* to let price increases absorb moderate supply shortfalls, and store only enough grain to preclude extreme reactions such as those occuring during the food crisis of 1972-1974?

A buffer stock that is accumulated when grain is cheap and is sold when it is dear would stabilize both quantities and prices. This would offset most of the ill effects of bad crop years and maintain market incentives. Unlike a simple probability scheme, the costs of a buffer stock integrated with the market are easily calculated, and its benefits are assessable. Also, a price-stabilizing buffer stock is the only scheme that could possibly function under 20th century socioeconomic arrangements for disposing of the world's food.

☐ How should the reserve's benefits be measured? Once we agree that prices are to be stabilized, the next task is to ascertain who gains and who loses from the operation. Consider, for example, the 1972-1974 period, characterized by unprecedented increases in grain prices. As a direct consequence, the food import bill of cereal-deficit countries increased dramatically, while exporters reaped the profits. Within all countries, grain producers and processors prospered, and real incomes of consumers (especially the poor) went down because of the food price inflation. As a result, a series of compensating macroeconomic adjustments took place.

From this catalog of effects of grain price inflation, we gather that one way to evaluate a price-stabilizing buffer stock is through foreign exchange gains and losses from stabilization. Had prices been stabilized in 1972-1974, exporting countries would have lost foreign exchange, and importing countries would have gained. Within countries, producers would have sold a stock — with a level fixed by the harvest — at a lower price, and lost from stabilization. Consumers would have purchased this same stock more cheaply, and also would have gained by consuming the grain put on the market from its stores by the buffer stock agency. The agency itself would have built up cash reserves from its sales, though these would presumably have been earmarked for future purchases when grain prices fell again. In an oversupply situation, the losers and gainers would be reversed, but the analysis is similar.

Adding up probable losses and gains over the years for relevant economic groups would allow us to foresee who might favor or oppose price stabilization: a wheat buffer stock would probably help consumers and importers, and harm producers and exporters. The inference is much less clear for feedgrains because demand curves are more nearly linear, producer response is greater, and trade is more open.

So far, we have been somewhat ambiguous about how a price-stabilizing buffer would operate. We have implied that it might buy either when worldwide crops are large, or when the relevant international grain price is low. These two response patterns are said to be induced by quantity and price triggers, respectively.

Any functioning buffer would, of course, utilize all information available, whether in the form of prices, quantities, or forecasts of either. Also, it would not announce its decision rules explicitly, since at best market participants could then offset any interventions it might make and at worst it could be ruined by speculation. Central bankers, the most influential market stabilizers in the world, are dour characters for just these reasons.

In practice, however, a functioning buffer stock would base most of its decisions on price signals. World grain markets are active and clear quickly, so price movements can indicate trends in supply and demand. For this reason, it is realistic to analyze a stock operating on the basis of price triggers, entering the market to buy (sell) when the world price falls (rises) to some lower (upper) bound. In other words, there is a "price band" that determines the buffer stock's activity. If the price in some market year stays within the band, the buffer stock agency does nothing. If the price reaches a limit, the agency intervenes until either the price returns within the band, or the stock's capacities are exhausted. Two parameters describe the capabilities of the stock: the width of its price band, and the maximum amount of grain it can buy for storage when the price is low. How these parameters affect stock behavior is illustrated quantitatively in the box on pages 48 and 49.

Besides the annual costs incurred on the grain it has in storage, the other major items in the buffer stock's accounts are the cash inflows and outflows it would realize on sales and purchases. Even an agency that bought cheap and sold dear might well have storage costs large enough to make it run a net loss over time. The larger the average amount of grain stored and the longer it remains there, the more likely is the buffer stock agency *not* to be profitable (even abstracting from the initial costs it will incur in stocking up). The determining factors seem to be:

☐ A wider price band means a longer waiting time between buying and selling operations, and higher storage costs. On the other hand, the margin between buying and selling prices would be greater, possibly by enough to cover the increased costs. The relationship between price band and buffer stock profits is ambiguous, since it also depends on the stock's capacity.

☐ As capacity increases for a given price band, so does the average amount stored, and profits decline.

☐ The magnitude of buy-sell operations will be influenced by demand elasticities in the current year and the exuberance of farmer supply response subsequently.

☐ As a necessary part of its operations, a buffer stock will increase world trade for other market participants. That is, its purchase and holding of stocks must increase

the value of exports or reduce the value of imports for nations already in the market before the reserve commences operations. In effect, the buffer stock "finances" a decrease in net imports (or an increase in net exports) of the rest of the world via its own deficit. Which countries will actually gain foreign exchange because of price stabilization depends on the elasticities, but clearly the likely beneficiaries should help make good the buffer stock's paper losses.

Even after this trade effect is netted out, a buffer stock may be expected to lose money over time, especially for tight price bands. When this likelihood was first discovered, it created some surprise. But a second thought clarifies: a buffer stock would protect consumers against uncommon events — crop failures every five years or so. Even if five- to ten-year grain futures contracts existed, the market would not hedge against major crop failures, because of private risk aversion and the storage costs involved: ". . . there are no profits to be earned by consistently investing in improbable prospects. . . ."

In effect, we are advocating a price-stabilizing buffer stock to stabilize and control the market. Price increases would bear part of the effects of crop shortfalls, but timely sales by the stock agency would keep the inflation within limits, and dampen the kind of panic which swept around the world between 1972 and 1974. The events of those years already demonstrate that the market is incapable of stabilizing itself in extreme situations.

Defining Emergency Relief

International consciousness about food aid in general is usually raised by unpleasant television pictures and news stories of disaster and famine in underdeveloped parts of the world. Timely procurement and distribution of grains in these instances is of incalculable human value. The main questions involve triggering and delivering that kind of relief.

Droughts and natural disasters are impossible to predict, and occur quite randomly across the world. Even so, a given region has a high probability of experiencing serious drought (or other catastrophe) over a long period of time, say 30 years. Therefore, emergency relief is better viewed in *flow* than in *stock* terms. Any commitment by the community of nations to assist one another in the case of food emergencies should be a continuing one, since catastrophes will continue to occur. In the case of food, flexibility of response is the main issue. It could be provided easily by cash instead of cereal commitments, since the actual tonnages of cereals required in emergencies are likely to be miniscule in comparison to world production or even trade.

Two bottlenecks slow most relief efforts. The discovery and announcement of an emergency can be stalled; and organization and delivery of supplies to the stricken area is often disorganized and slow. Famine strikes at random across time and location. So food reserves dispersed idly

Continued on p. 50

Snags in the World Forum

Many proposals for "food reserves" have appeared since the Rome World Food Conference in 1974. Even in some of the more recent ones, the three food security objectives — price stabilization, food aid, and emergency relief — are confused. We simply reiterate here that both food aid and emergency relief are *flows* of grain that must be maintained indefinitely, while price stabilization can be abetted by adroit manipulation of a *stock*. Holding very large stocks in some corner of the world as insurance against an emergency that might occur just there is likely to be expensive, and the total shortfall will not be large in comparison to world trade. Hence, it makes economic sense to divert flows of grain to the region at the appropriate time. Contrariwise, flows of food (manna excepted) will not be forthcoming when the world as a whole has a bad harvest year; stocks in the control of some sort of Buffer Stock Agency would be desirable to moderate food price inflation and soothe market disruption and panic.

So serious food security proposals boil down to discussion of price-stabilizing stocks, with provision for emergency relief operations and food aid to countries that under one sort of allocation rule or another deserve it.

There are three probable points of divergence in the negotiations about grain reserves that are now progressing in various international fora (the London-based International Wheat Council, the "Tokyo Round" of tariff-reduction talks in Geneva, the discussions in U.N.-related agencies such as the Food and Agriculture Organization and the World Food Council in Rome): size of reserves; triggering mechanisms; and burden-sharing. On at least a few of these broad issues, there seems to have been some progress.

As discussed in the text, the reserve proposals that were offered two or three years ago tended to cluster around stocks of 25 to 30 mmt, a horrendously expensive quantity of grain to maintain. Press reports suggest that recent proposals run to from 10 to 20 mmt for wheat, a much more reasonable quantity in view of our econometric results.

Two years ago, there was substantial disagreement between the major negotiators on triggers. The U.S., tacitly backed by other exporting countries, favored quantity triggers for a grain reserve, to its own benefit in times of shortage because statistically reliable information about crop shortfalls at a global level usually arrives late, long after prices have skyrocketed.

As grain stocks have increased and prices softened, the exporting countries have come to look more benignly on market regulation. The Common Market, the other major trader, in any case inclines toward this point of view because of its Common Agricultural Policy (whereby farmer subsidy payments are tied to world prices) and more basically because of its *dirigiste* ideological approach to economic problems.

The current discussions focus around a U.S. proposal of September, 1977, to the International Wheat Council for a price-triggered reserve of (according to the press leaks, but not the proposal) 15 mmt. Who is to pay for the relatively modest losses that such a reserve would run remains unclear. Both the econometric analysis of the type discussed here and the broader political issues in terms of worldwide attempts to exit from the present conjuncture will have some role in fixing what share of the burdens of grain reserves the nations will shoulder, if they shoulder them at all. — *L.T.*

Analyzing Grain Reserves by the Numbers

A Buffer Stock Agency that stores from 10 to 15 million metric tons (mmt) of grain would find that it has enough grain to maintain price stability, yet not so much that storage becomes a momentous financial headache. This amount, and most of the other numerical results mentioned in this article, come from computer simulations based on a simple, though flexible, model of demand and supply for grains. For most countries, the model works in the following way:

There is assumed to be a price at which the country can import grains: total imports depend on this world price, as well as on the current size of the harvest and the amount of food aid the country receives. The higher the world price, the lower imports will be, though the elasticity coefficient measuring the price response is usually not large. A small harvest will lead the country to import more, although shortfalls are not made up completely from international trade (especially in poor countries, where low harvests often lead to severe food shortages in the politically passive countryside). Similarly, increased foreign food aid leads to increased total imports, but not by very much. This same general treatment applies to countries that export (or have negative imports). Here, of course, a world price increase leads to greater sales abroad.

In any year, the world price itself is determined by the condition that net imports (positive or negative) of all countries sum to zero. When the price adjusts to satisfy this condition, then so does supply in each country — the harvest plus the amount imported at the market-clearing world price. This fixed supply determines the consumers' price in the country; it can be viewed as rising (falling) until consumer demand declines (increases) to meet supply. In most countries, the price farmers receive for growing grain is not closely related to the price consumers pay. Governments almost always intervene to protect either consumer or producer interests. If the consumer price does seem to have some effect on the producer price, however, the model takes that into account in calculating a new value for the latter. The new producer price determines the acreage that farmers plant; the weather (treated as a random "shock" to the system in each country) determines crop yield per acre, and the total harvest in the next year.

This three-function model (simplified in some cases) was fitted statistically to 19 countries or regions for the period from 1950 to 1971 (approximately, depending on the data for each country). To analyze probable future market behavior, 200 20-year "histories" of the grain trade were simulated using the model, beginning in 1974. For each year in each history, 19 random numbers were drawn to represent possible trade and production shifts in each country and region. The variance in each country's set of random numbers was adjusted to take account of its historical fluctuations — for example, the facts that the standard deviation of Russian wheat harvests is 9.3 mmt while only 3.2 mmt in the U.S. were thus accounted for.

An international Buffer Stock Agency was then introduced into the simulations, buying or selling grain when the world price reached lower or upper pre-set price bands, respectively. If the Agency's purchases ran its stores against a preset capacity limit, or if it sold out its stocks, it was assumed to operate only within these limitations. In such cases, the price moved outside the pre-set band to drive remaining world net imports to zero. For all simulations, the price band was assumed to be symmetric about a long-run equilibrium world price, so that its width can be described by the value of the upper price boundary alone.

As mentioned in the text, one measure of gains from price stabilization is the amount of extra foreign exchange a country earns (spends) on its grain exports (imports). The upper chart shows that over the 20-year history of the Agency that we simulated, the U.S.S.R. might be expected to save $1 to $2 billion in foreign exchange from stabilized prices, while the major exporting countries (U.S., Australia, and Canada) would lose. The U.S.S.R. gains because of its own highly variable harvests and import demands — price stabilization from the outside can only help in such a situation. The exporters lose because they cannot reap large windfall gains from

high world prices as they did in 1972-1974. Argentina, an exporter, is a special case because its historical internal market dynamics have been unstable with tendencies toward ever widening price fluctuations. Thus Argentina also benefits from external price stabilization.

Most wheat importing countries, especially the less developed ones, might also benefit from price stabilization. The European Community, either a net importer or exporter depending on circumstances, is little affected. As the chart shows, these gains or losses decline as the price upper boundary rises from the market equilibrium value of $140 per metric ton (1974 prices). This simply reflects less and less intervention with the free market. Also, it should be emphasized that these results are only averages across the 200 market histories that we simulated. Any single history, like the one that will in fact be observed, could throw up completely different results. Even the best stochastic computer simulations tell relatively little about what the great British economist Maynard Keynes once called "the dark forces of time and ignorance" that we face.

The real purpose of an Agency, of course, is not to help or harm specific countries, but to moderate excessive price fluctuations. The chart below, something that only an economist could love, shows some of the trade-offs involved. The lines sloping off to the "east" in the figure show how much the standard deviation of the world wheat price (across the 200 simulations) is *reduced* by an Agency operating with different price boundaries (vertical axis) and capacities (horizontal axis). As the upper price boundary decreases, there is more stabilization, as the successively lower "25 per cent," "28 per cent," etc., curves imply. That is, the "35 per cent" curve represents a reduction in price standard deviation by that amount. In other terms, without the Agency, the world price might be expected to rise above $200 per metric ton three years in every 20. If its standard deviation is reduced by 35 per cent, it will rise above $200 only one year in 20.

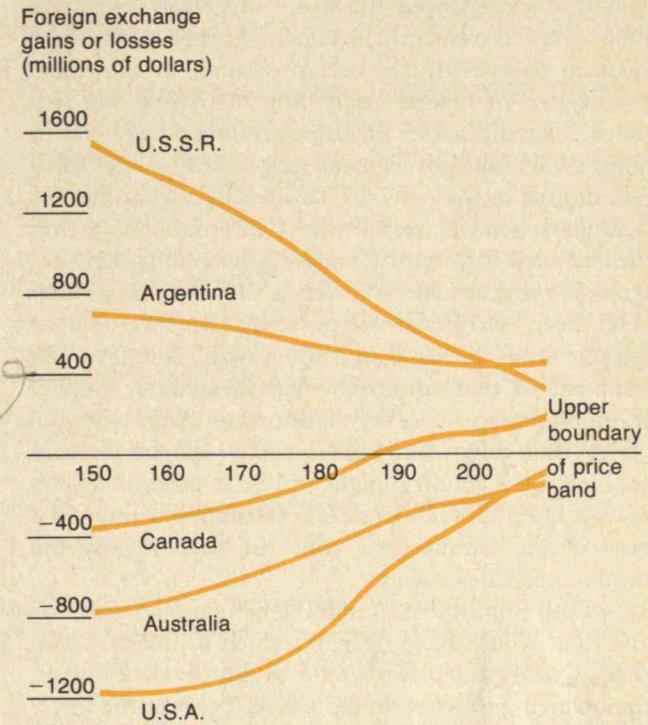
Observe how the stabilization curves flatten out as the Agency's capacity reaches 10 or 15 mmt. This suggests that the extra benefits from extra capacity beyond these levels are not likely to be large. Similarly, the more or less vertical lines labeled "600," "400," etc., show Agency profits (negative if losses). Again, losses go up fairly sharply as a function of the Agency capacity. For a given capacity, they are only moderately affected by the price bandwidth.

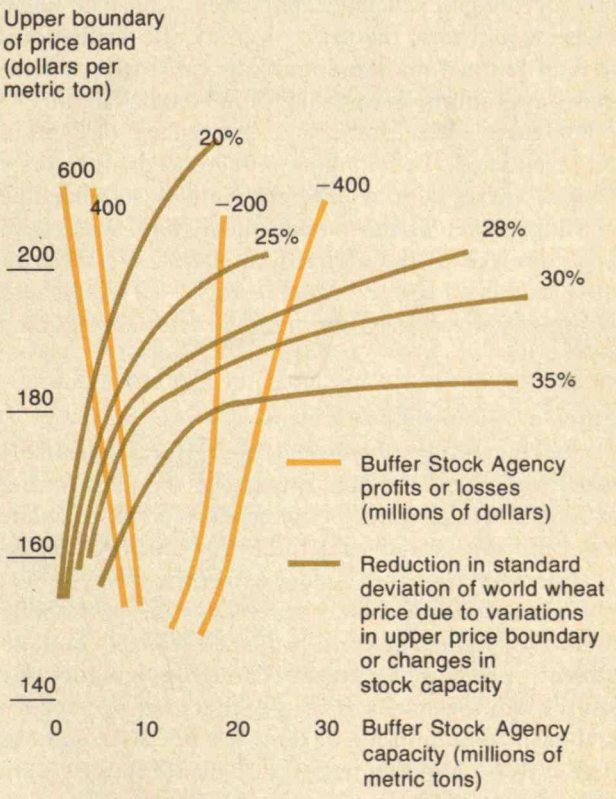
The general conclusions from the wheat simulations are:

☐ A Buffer Stock Agency would help importers (and consumers) and harm exporters (and producers), though the statistically expected impact in each year would not be large.

☐ Apparently, a Buffer Stock Agency could help stabilize world prices, and in that way decrease the likelihood that the Food Crisis of 1972-74 would repeat. However, a 30 mmt capacity buffer stock would not add much stabilizing power to that which a 15 mmt stock can attain, and for that reason large stocks are probably not advisable.

Companion simulations for feedgrains suggest that the second conclusion retains its validity with a target stock of 5 to 10 mmt, but the gainers and losers from stabilization are reversed. Under these circumstances, joint creation of stocks for both wheat and feedgrains might prove politically attractive. — *L.T.*





over the globe would serve only to accumulate storage costs; a speedier response could be guaranteed by centralizing the relief agency.

At the international level, most famine relief can be activated only *after* the government of the afflicted country announces that severe food shortages exist. One assumes that in most cases national authorities would act rapidly on behalf of their people. But this is not always the case. Famine may conveniently decimate groups within the population opposed to the current regime, or the rulers may fear loss of face in requesting help from abroad. Cases of belated requests for help certainly occur — as in Ethiopia, where the government suppressed news of famine conditions in the early 1970s literally for months. If governments behave irresponsibly, international action might be called for, but the matter is inevitably delicate.

Bypassing this touchy issue, let us suppose that a relief fund has been established. Suppose also that severe threat of famine arises in some underdeveloped country. The government of that country would presumably import grain in an attempt to cover the shortfall. After exhausting both its foreign exchange capacity and its international credit, the country might still be in need. In such a case, it would presumably ask for international aid, and a portion of the famine fund could be used to buy the additional needed supplies.

Since both imports and famine relief supplies paid for by the fund would have to be obtained in international markets, world grain prices would have an evident impact on the financing of relief. In a tight market year the international price would be high. The stricken country, even with the relief fund, could purchase only a quantity limited by its foreign exchange capabilities. The large single purchase would raise the price of grain still further. Adverse international market conditions can frustrate famine relief operations, even though funds are available.

Under these circumstances, a price-stabilizing grain buffer stock would be selling its supplies to dampen price increases. These sales would incidentally stabilize the purchasing power of the famine relief fund, and could even be directed to the afflicted countries. We discover another rationale for a grain buffer stock — it would lend order and effectiveness to international efforts for famine relief.

Magnitude of Relief Requirements

The actual magnitude of required relief efforts is probably so small as to have minimal impact on the grain buffer stock or the world market in general. We can calculate this amount, as we did with the buffer stock, either by using a probability-based model or on the basis of economic considerations. Not surprisingly, the probability calculations can be juggled to produce extremely high estimates of "necessary" reserves. Though psychologically reassuring, storing stocks of the size that comes out of the "worst case" assumptions of these studies is of dubious economic value. Holding tens of millions of tons of grain idle for several years awaiting doomsday is a very costly proposition. Even when the stocks are used, they need not bring any great benefits, since even in a crisis consumption can adjust somewhat without overwhelming hardship. Much more useful would be a guaranteed flow of funds to a relief agency, which could bring quick succor by using the world market and shipping facilities (or the stores of a price-stabilizing grain reserve).

We base our conclusion on the following facts. The major economic impact of a severe crop failure in a poor, agricultural country is on purchasing power. The resulting internal loss of aggregate demand will not be remedied unless emergency food supplies are both donated from abroad and directed to those harmed economically by the disaster. Emergency grain reserves must therefore be viewed as supporting food aid, but aid of a special kind: its destinations will vary from region to region and time to time. An estimate of required yearly average flows can be inferred from recent grain import patterns for underdeveloped countries. The Most Severely Affected (MSA) countries, currently numbering 44, obtain most of their imports through commercial channels and another significant portion through food aid. F.A.O. estimates that in 1975-1976 there was a shortfall in MSA import capacity of about 2 mmt. Emergency relief requirements in 1975-1976 would presumably have been less than this figure, since MSA countries are still recovering from their reduced import capacities due to the oil and food price explosions of 1972-1974. Hence, some part of the shortfall must be attributed to simple lack of purchasing power and not disaster per se.

Another estimate of the required flow is embodied in a Swedish proposal to the World Food Conference that enough grain be on hand to feed 2 million famine victims for a year. At 250 kilograms of grain per person, this works out to 500,000 metric tons. If these two estimates are taken as spanning the range of potential MSA grain needs that would not otherwise be covered, then a yearly *flow* of about 1 mmt seems a reasonable guess of the amount of required emergency supplies. The crudeness of this estimate is apparent — it should be supplemented with analyses both of magnitudes of recent relief efforts and likely future production shortfall-induced import requirements in MSA countries under realistic assumptions about world food prices and foreign exchange positions.

Translated into dollars, 1 mmt of grain amounts to a flow of only about $100 to $150 million, including transport costs to the afflicted regions. This is of course only a very small fraction of the total aid currently directed to the MSA countries.

The machinery for delivering emergency supplies is currently supplied through the World Food Programme, the U.N. Disaster Relief program, the Red Cross, and various other charitable organizations. Their problem in past disasters has not been lack of organization but lack of timely available funds and supplies. But their status prevents them from delivering resources for relief efforts until after the disaster reaches headline proportions. They must wait until the overworked parliaments of the donor countries go through their established procedures for appropriating funds for unilateral or multilateral action. The essentials lacking for timely delivery of aid are a mechanism for rapid certification that a disaster has oc-

curred, and assurance that in a given year stocks of food or funds will be at hand for emergency use. If stocks were to be guaranteed, then of course any unused portions could carry over to subsequent years.

India is particularly concerned about famines, and has in effect established its own emergency reserve. Given the difficulties of storage in the tropics, this is likely to prove an expensive exercise. If, for instance, 1 mmt of wheat is bought (or not sold) internationally by India, stored domestically for five years before it is needed, and then distributed to famine stricken areas, the total cost to the government, including purchasing costs, storage cost and opportunity cost of the funds is about $250 million. If instead this sum were saved as foreign exchange reserves, the government might be more flexible in the time of the crisis.

Apparently, the outcry of underdeveloped countries during the recent food crisis was due not only to high international prices but also to the unavailability of supplies — a much more dangerous situation from a subsistence country's point of view. The existence of an international stabilization grain reserve would provide the needed assurances for the third world. Poor countries might choose to supplement it with their own physical or monetary reserves, but their perceptions about the magnitudes required might be considerably reduced.

Food Aid: A Policy Dilemma

Food aid and grain reserves are inextricably intertwined in politician's pronouncements about food problems, although to a large extent they are economically separate entities. In the following paragraphs, we will outline briefly the major issues arising in past debate about food aid, and summarize the evidence regarding how it is utilized by recipient countries.

If we ignore public condemnation of blatantly political uses of food aid, then we are left with three main questions which have figured in past debate. Who should pay for food aid? Who should receive food aid? How can food distribution systems be set up within the recipient country to minimize interference with agricultural production incentives?

The question of payment came to the fore recently as excess grain and other food stocks in exporting countries declined. Around 1971 or 1972, aid ceased to be useful as a vent for surpluses generated by the U.S., for example, to support high producer-price agricultural policies. Subsequent Atlantic Community pressure on oil producers to help bear the cost of food aid shipments is an obvious corollary of the new world trade situation.

On the other side of the ethical ledger, the feeling exists in some policy-making circles that poor countries have an absolute "need" for aid, which should be satisfied by the rich. The U.S. Congress has been said to be a bastion of this doctrine. If this is so, then a strong political case can be made for food donations. Moreover, if the chronic oversupply situation of the 1960s reappears (a not improbable development), then the U.S. and Canada would again be tempted to act as discriminating oligopolists, selling their own grain surpluses to poor countries at reduced prices in the form of "source-tied" foreign aid. These arguments suggest that the problem of who should pay for aid in the future may not be pressing. If the present trend of good crop years continues, the exporters will be hastening to shoulder the burden.

Politics entered into the selection of food aid recipients when in the early 1970s Congress sought to curtail the use of food aid as a means for supporting the war in Vietnam. Legislators now are more conscious of the politically coercive uses of food, and a few are pushing to direct food flows to more humanitarian ends.

This internal U.S. discussion overlapped with new international awareness of the plight of the MSA countries and the wide publicity given the Bangladesh and Sahel famine relief efforts. The notion of need implies that countries with unclosable food supply or foreign exchange gaps are, and ought to be, the first in line for continuing international help. Ethically appealing as this is, it provides no guidance as to the magnitude of aid required, nor does it imply any criteria which may be used to judge the effectiveness of food donations. So the question arises: what do recipient countries do themselves to absorb food aid inflows?

Food donations may have the effect of reducing a country's incentive to increase its agricultural production. Guaranteed aid could diminish government enthusiasm for research and financing extension services, and so on. This alleged impact on policy is of somewhat mystical nature and would be extremely hard to quantify, but no doubt has been important in some cases.

A more mundane market effect can also be identified. The possibility exists that in a domestic market where the government does not intervene to separate consumer and producer prices, food aid inflows will add to short-run supply, depress the price level, and so influence farmers to curtail output in the next few harvests.

If aid is really added to marketed supply, the reduction of price — and subsequently output — depends on demand and supply elasticities. If on the other hand the food is distributed *gratis* to those who could not otherwise afford to enter the market, domestic price and production would not be affected. If the government sells the donated food through the country's usual commercial channels, the revenue can be categorized as a domestic counterpart of general economic aid. Similarly, re-export of the donations can be a convenient source of foreign exchange.

As in any balance of payments problem, this internal market elasticity approach can be supplemented by asking how the economy adjusts macroeconomically to absorb the extra foreign exchange inflow that the donations represent. This amounts to asking whether the donations increase the supply level that commercial imports would otherwise have provided. If the aid is *not* additional, and merely replaces imports, then on the domestic front it would not depress internal producer prices. In balance of payments terms it would be equivalent to general economic aid. An important question arises — how much does aid add to the quantity imported, and how much does it replace imports that the government would have

been making in any case?

The empirical evidence on this "additionality" question is suggestive, but not clear-cut. A plausible model has the government of a representative underdeveloped country setting a target for the amount of food it will make available in urban areas to satisfy the demands of the politically potent middle- and low-income groups there. The necessary supplies of grain can be acquired either from the rural interior of the country or from abroad. Internally, the power of the state can be mobilized to obtain a fixed amount of grain from the countryside, which implies that harvest shortfalls are borne by the rural poor. In the exterior, it is rational to buy grain from the cheapest supplier; hence available food aid at concessional terms will first be acquired by the government. But the fact that food aid can be obtained does not mean that the government will import much more than it otherwise had planned. If imports don't increase, then food aid is not additional; it is better treated as general economic aid, *not* as a device for channeling food to "the hungry people who need it most."

In light of this model, special steps within the poor country are required to make donated food additional to otherwise targeted imports, and really useful to the poor. Econometric analysis of import data for a number of countries for the last 25 years suggests that few have taken the requisite internal distributional steps. India with its Fair Price Shops seems to be an exception. This system of distributing food has probably been able to utilize imports to increase the total supply, in particular the quantity rationed out to the undernourished poor.

How Much Food to Supply?

Food available for aid seems likely to increase in the near future, as stocks build up in the grain exporting countries. If the recipient poor countries continue to use the concessionally available grain as general purpose foreign aid, then it is reasonable to ask whether food aid is economically efficient. Both product-tying of aid (forcing the aid to be food) and source-tying (forcing the food to be purchased from the donor) can exact a high price from the recipient. If the donated food is converted to foreign exchange, then its value is diminished by the constraints placed on the recipient by the donor. If it is used as food, then source-tying — forcing it to come from a specific place — may increase transport costs, reduce perceived quality, and so on.

A second issue to be addressed is whether reserves should be set aside specifically for food aid. Remember that by its very nature, food aid has to be a flow — a constant diversion of some fraction of world supplies to poor countries, year after year. The flow can be characterized in several ways:

☐ It should be separate from and additional to grain allocations for emergency relief.

☐ Recipient governments ought to be assured of the amount of aid they can expect over the next few years, for their own planning purposes. Of course, they should also be able to count on emergency relief aid when necessary.

☐ Since the evidence indicates that most importing governments set cereal-inflow targets that they will satisfy, the magnitude of food aid flows becomes almost a question of foreign exchange budgeting: how much of the $X hundred million per year of food that country A will almost surely be importing should be covered by donors? If most countries use the flows as general aid, then the type of calculations used to determine the volume of the latter become relevant.

☐ Insofar as some countries make special efforts to transform the food inflows into extra supplies directed toward poor people, they should receive favorable consideration for larger allocations.

Programming all these flows would presumably be simplified if world grain price stability could be guaranteed. A buffer stock thus enters as an important component of future food aid deliberations. The buffer could also conceivably be used as a working stock to help keep aid flows moving, although this would be mostly a matter of convenience. As with emergency relief, the buffer stock is important because it would stabilize prices and make planning for disbursement and use of aid much easier.

Finally, if food aid flows have little direct impact on poor country import demand functions, then they will not have much feedback on an international grain buffer stock either. The buffer would basically operate as an N + 1st country in international trade, and our results indicate that there would be minimal impact from aid through cereal trade on its operations. If aid flows begin to shift poor country import demands in the future, then they might make the task of price stabilization easier by smoothing trade flows.

Proposals for a Reserve Policy

Wheat reserves would have to be the pivot of any viable price stabilization scheme. Wheat is by far the most extensively traded grain, and its price is the most volatile. Since wheat is a major component of most advanced country diets, control of its price could stave off inflationary pressures in the rich countries as well as helping ease foreign exchange constraints on growth in the underdeveloped part of the world. Finally, substitution relationships among wheat and feedgrains are such that stabilization of the world wheat price would help stabilize other grain markets as well.

Our econometric analysis (*see page 49*) suggests that the size of an international wheat reserve could be quite modest, preferably smaller than 15 mmt, and most likely in the range of 10-15 mmt. These sizes are far smaller than those appearing in many proposals for grain reserves that appeared in wake of the World Food Conference. The reserve should be built under easy market conditions (such as those this past summer), when the world wheat price is around $110-130/mmt. Reserves should be held *firmly* until a time such that world (real) price is in the vicinity of $170-190/mmt at which point they would be released at these prices, with priority given to countries that are participating in a reserve scheme, especially less developed countries.

If a policy of this type is followed, our results indicate that price fluctuations can be substantially reduced — the

number of times the wheat price rises above $200 per ton (from a normal price of $140) might be expected to fall from three years out of 20 down to one. The costs of stock operations required to achieve this degree of stabilization would be relatively small: an expenditure of between $1 billion and $1.5 billion over a period of years to build up the reserve, and operating costs of about $100 million per year thereafter.

The reserves should preferably be held internationally, but if this proves a political impossibility, then certainly they should be held publicly rather than privately (since private storage efforts are likely to be quite inadequate). With a wide price band and small magnitude, international reserves need not interfere with the normal workings of the market, but instead would prevent abnormal behavior during times of crises. Nationally held reserves would be a good substitute for an international program only if the holding government(s) acted in a stabilizing fashion, purchasing when prices were low and selling when prices were high. U.S. behavior during 1972-1973 is not reassuring on this point, since it sold its stocks early to the U.S.S.R. at very low price levels and then let speculators take advantage of the ensuing panic. Insulation of the management of a reserve scheme from the kind of foreign policy pressures which gave rise to the U.S.-U.S.S.R. grain deal would be an unavoidable prior condition for its successful functioning. How then to prevent this "management" from degenerating into yet another proliferated United Nations agency becomes a question which must be faced and *answered* before the scheme can be set up. The fact that the reserve will have to participate in an active, competitive market is perhaps a hopeful omen on this front.

Within the U.S., farm groups oppose grain reserve sales in periods of high prices because they want to reap the excess profits. However, when prices are low they are very vocal in advocating reserve purchases and support of falling prices. Since consumers pay taxes to finance reserve stocks in periods of glut, it is only reasonable that they recoup some of their investment via lower prices and less inflation in periods of shortage. The reserve stock we advocate incorporates a wide price band, so that farm groups might be less vocally opposed than they would be to more stringent stabilization.

In the case of internationally held reserves the burden of financing should fall on the large developed trading countries, such as the U.S., Canada, Australia, Japan, the European community, and especially the Soviet Union as the major likely beneficiary. Since there appears to be some offset between gainers and losers in wheat and feedgrain reserves, it is possible that joint establishment of two buffer stocks would make economic sense.

In any case, participation in the reserve scheme should be the criterion for eligibility to purchase in periods of high prices, and as many countries as possible should be encouraged to join.

Turning to the issue of emergency relief, our rough analysis suggests that required annual flow of grain are likely to be quite small on the average, on the order of 1 mmt per year. Establishment of famine relief stockpiles in remote parts of vulnerable countries might be worthwhile, but it is likely that their cost and flexibility would limit their usefulness. Rather, readily available emergency relief funds earmarked specially for disaster could prove to be a better solution. Disbursement of these funds for purchase of grain in world markets would be requested by afflicted countries, and decided upon in light of their foreign exchange positions and internal relief efforts. The annual flow of funds toward relief might be expected to amount to $100-$200 million, a small share of total foreign aid given to MSA countries.

The fact that disasters are of random location and magnitude — but almost invariably highly localized — points to the necessity of timely organization and assurance of relief funds or supplies. Given the relatively small magnitude of the probable costs, a scheme designed specifically for famine relief (but perhaps with the right of rapid withdrawal from internationally held stocks) would be both feasible and potentially of incalculable value in alleviating human suffering.

With the notable exception of India, food aid seems to have been used in the past by recipient countries as a source of general economic assistance, and not as a means for improving the nutritional status of vulnerable groups within the population. In strictly economic terms, food aid as a device for transferring foreign exchange from rich countries to poor ones is not efficient. In fact, it probably served as a vehicle for discriminatory oligopoly pricing by North American grain exporters during the surplus years of the 1960s.

The strictly *economic* conclusion we draw is that in principle food aid should be phased out and replaced by general economic assistance in the future, except for countries such as India which undertake the domestic policies necessary to make donated food flows add to normal levels of imports.

To this general recommendation, a number of qualifications must be added. First, it is distinctly possible that political decisionmakers in many advanced countries, and especially the U.S., look with more favor on donations of food than donations of money (especially if a condition of generalized excess supply of cereals occurs again). A large amount of food aid used inefficiently as a form of general economic assistance is clearly preferable to a small amount of the real thing. Second, some countries are simply chronically unable to satisfy domestic food demand with their own resources (Egypt being a case in point). Since such countries will be importing anyway, there is much to be said for giving them favorable terms (instead of seeing them forced to borrow short-term money at 20 per cent interest to pay for irreducible imports, as occurred during the food crisis). Again, interactions between price stabilization and needs for other forms of aid become apparent, but efforts to direct all possible aid flows toward MSA countries remain paramount.

Finally, it is worth recalling that general food aid, like emergency relief, is essentially a flow, with new commitments required year after year. An international buffer stock might in normal times be used as a pipeline reserve

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to support such flows, but for practical purposes new resources will have to go into aid programs with each advanced country budget exercise. Stabilization and guarantee of the amounts of aid flows over time would be of inestimable use to recipient countries in planning their own internal food policy and agricultural development efforts.

Suggested Readings

Sensible discussions of food and nutrition issues in literature accessible to the intelligent layperson are unfortunately few and far between. The popular literature tends to be dominated by biased reporters. Fairly written books and reports in many cases are available only in large libraries. Some of these are:

Jagdish N. Bhagwati (ed.), *The New International Economic Order: The North-South Debate;* Cambridge, Mass. and London, England: The M.I.T. Press, 1977. The papers by D. Gale Johnson, by Alexander Sarris and Lance Taylor, and by Robert Solow provide a balanced view of anti- and pro-market intervention approaches to food security.

Food and Agricultural Organization of the United Nations, "Food Reserve Policies for World Food Security: A Consultant Study on Alternative Approaches," Rome, Italy (ESC: CSP/75/2), January, 1975. This elaborates upon and extends many of the arguments in the Johnson paper cited above.

Fred H. Sanderson, "Next Steps on Grain Reserves," *Food Policy,* Vol. 2, No. 4, November, 1977, pp. 267-76. Reviews current grain reserve negotiations and advocates reserve stocks of over 100 million tons. Does not discuss how much they would cost, or the degree of extra protection against price excursions such enormous stocks would provide.

Lance Taylor, Alexander H. Sarris and Philip C. Abbott, "Grain Reserves, Emergency Relief and Food Aid," prepared for the Overseas Development Council, 1977: forthcoming in a book to be edited by William Cline on the New International Economic Order. This report extends considerably the arguments summarized here.

Phillip Trezise, *International Grain Reserves,* Washington, D.C.: The Brookings Institution, 1976. This book reviews emergency relief requirements (somewhat apocalyptically) and offers political discussions of burden-sharing.

United States Congress, *International Food Reserves: Background and Current Proposals,* prepared for House Committee on Foreign Affairs, October, 1974. A good review of some of the older proposals for reserve schemes is offered here, including an important one by the former F.A.O. Secretary-General, A. Boerma.

Lance Taylor has been at M.I.T. since 1974, holding a joint professorship in the Departments of Economics and of Nutrition and Food Science. His main research interests are in food and macroeconomic problems of underdeveloped countries, and he works frequently with country governments and international agencies on these issues. Before coming to M.I.T., he taught at Harvard, and took his degrees there, at Lund University in Sweden, and at the California Institute of Technology. He grew up in a small rural town in Idaho, and "unlike most of my colleagues, can at least tell the difference between corn and wheat trees at a second glance."

Alexander H. Sarris and **Philip C. Abbott** both received Ph.D.s in Economics from M.I.T. in 1976. Dr. Abbott is now teaching at Northeastern University, and Dr. Sarris at the University of California at Berkeley.

The authors wish to acknowledge research support from the International Nutrition Policy and Planning Program at M.I.T., the National Science Foundation, and the Overseas Development Council.

Boulding

Continued from p. 5

nipulating the relative price structure may be much more effective in achieving desired changes than prohibitions, regulations, and sanctions.

Even so, we will get much further if we think of the positive and the negative as complements rather than as competitors, as supplements rather than as alternatives. Merely getting rid of the negative is particularly dangerous. In social systems, minus minus does not make plus. But all too often negative-negative thinking masquerades as positive, especially among the radicals, who think it is sufficient to be against evil rather than for good. Good and bad are inescapably joint products. And getting rid of a particular bad may get rid of a good too.

The great vice of the moralist is to suppose that proving that something is bad is a sufficient argument against it. Not so; the moralist must also prove that something else is better. These are hard questions for the virtuous. A good virtue may be the enemy of a better, and it is disastrously easy to do harm in the name of doing good. □

Salisbury

Continued from p. 8

then, is the destroyer and the restorer is peaceful nuclear energy in the engineer's pantheon. But, the intrinsic danger of this technology presents an imponderable risk. Thus, it is not surprising that the environmentalists should lump nuclear energy together with atomic weapons as the destroyer and turn to another source, solar energy, as the restorer.

"(Contemporary man's) gods and demons have not disappeared at all; they have merely got new names. They keep him on the run with restlessness, vague apprehensions, psychological complications . . ." wrote psychologist Carl G. Jung in *Man and His Symbols*. Thus nuclear energy represents a kind of Promethean flame stolen from the gods, on the one hand, and a mechanical demon on the other.

Unfortunately, this conflict between divergent beliefs makes it virtually impossible to reach a wise decision on the proliferation of nuclear energy. As with religious clashes of the past, disruption and intolerance are the primary fruits of the disagreement. □

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Trend of Affairs

LNG Safety: A Matter of Scale

The size of the enormous tankers that ferry liquefied natural gas from wellhead country to delivery port foils the imagination. One tanker now on the drawing board will carry 165,000 cubic meters of LNG — enough to bury a football field under 125 ft. of liquefied gas. That volume of LNG could cover 600 football fields to the same depth after being warmed from its −259° F. liquefying temperature and converted back to natural gas.

Now imagine a lighted match.

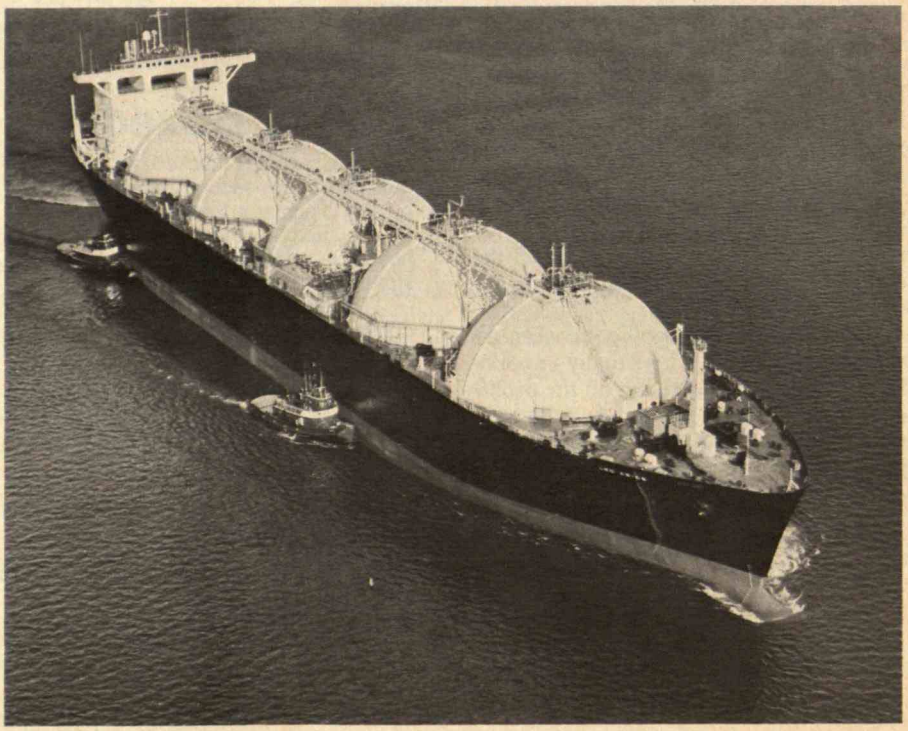
It is an energy planners' nightmare. As a result, they're approaching the coming increased importation of natural gas on tiptoe. Precise research is being demanded to support each decision made on tanker design and regulation, terminal siting and operation, and shipping safety, in an effort to prevent tanker collisions in busy harbors, storage tank accidents, and ship-to-tank spills that would release the rapidly expanding, highly volatile LNG.

The time to conduct such research is short. Today the U.S. imports only about 0.1 per cent of its natural gas, carried by one lone tanker to the only receiving area in the country, located near Boston. But by 1985, the congressional Office of Technology Assessment (O.T.A.) predicts that 41 LNG tankers will be needed to keep up with 5 to 15 per cent of U.S. imported gas needs.

At this time, cautious local, state, and federal regulatory agencies require a potential LNG importer to amass a stack of over 130 permits and licenses before opening a new LNG facility. This process has been known to drag on for more than three years.

Such caution may be excessive when applied only to the storage tanks. Traditionally used for power "peak shaving" by local gas companies, LNG is now stored in 60 locations across the country, and not one of the tanks in these places has yet explosively blown its top. Two exceptions to an otherwise perfect record — neither involving an LNG explosion — are not likely to be repeated. In 1944 a storage tank in Cleveland failed; its contents escaped and ignited; the ensuing fire killed 128 people and halted exploitation of LNG for two decades. In a freak accident during 1973, 40 workmen repairing an empty storage tank on Staten Island were crushed when hot gases from an accidental insulation fire lifted the roof of the airtight tank and dropped it upon them.

Today's concern for tanker safety stems



LNG Aries, one of two identical 125,000 cubic meter liquefied natural gas tankers built in the U.S., leaves the General Dynamics shipyard in Quincy, Mass., for sea trials. The ship will transport LNG at −265° F in five 120-foot diameter spherical aluminum tanks. It carries a crew of 30, is 936 feet long, weights 95,000 tons, and can sail "in excess of" 20 knots. (Photo: General Dynamics)

from the fact that larger and more numerous LNG tankers will soon be trundling between producing and consuming countries. To accommodate these ships, LNG-handling facilities two to four times the size of existing storage plants will have to be built near busy seaports.

"Legitimate concerns are raised regarding the consequences of a collision involving an LNG tanker, an earthquake centered near an LNG storage tank, a plane crash. . . . Would the results be catastrophic?" asked Arthur D. Little researcher Elisabeth M. Drake at a symposium on LNG safety held at M.I.T. this fall. "Is our technology sufficiently advanced to allow LNG importation to proceed with acceptable risk to the general public?"

Quantitative risk assessment in these cases is preferable to intuitive judgment. But according to the O.T.A., the results of assessments that have been made by no means agree, and, "it is unlikely that the U.S. can afford the time and money to conduct enough research to resolve the differences and come to firm decisions about the safety and behavior of LNG."

Estimates of the likelihood of ship collisions can be made with some confidence. "We have lots of operating experience" from which to draw, says Dr. Drake. Donald Allan, an A.D.L. colleague, has estimated that at the rate of one tanker delivery per week, a spill from a ship headed to the Staten Island facility would occur once in 130,000 years. Since current Coast Guard regulations require that an LNG tanker enter a harbor only after the harbor has been cleared of all other ship traffic, this estimate seems reasonable.

But other factors — the extent and probability of fire, explosion, and the damage these might cause — are harder to figure. Laboratory experiments on a small scale have measured flameless vapor explosions (*see box*), the expansion rates of vapor clouds of natural gas, and the boil-off rates of natural gas. But, as M.I.T. Professor James Fay points out, the data from such small-scale experiments cannot always be validly extrapolated to spill sizes many orders of magnitude larger than the experimental models. "The important physical effects expected to be observed following LNG spills will vary with spill volume," Professor Fay said.

Because gas pipelines already crisscross the nation, LNG is a well established energy source material. But without the needed — and expensive — research support beyond the small-scale laboratory stage, the costs and benefits of increased LNG shipping and handling cannot be weighed precisely. — *S.J.N.* □

Laser Chemistry for New Energy

The revolution triggered by lasers in countless scientific laboratories and in the practical arts of communication and measurement is nowhere near complete. Indeed, write Professors Jeffrey I. Steinfeld and Mark S. Wrighton, two M.I.T. chemists reporting on a National Science Foundation workshop, "the laser has only begun to be exploited." In the case of chemistry — and considering only applications in the production of energy — new research ". . . may ultimately lead to a series of major breakthroughs," which may themselves amount to a minor revolution.

Since early in this decade it's been clear that lasers might be used to separate the isotope uranium-235, required as fuel for nuclear reactors, from the vastly more common uranium-238. The separation process, or enrichment, is accomplished conventionally by the gaseous diffusion method, developed during World War II, which is slow, expensive, and energy-intensive.

Laser enrichment would begin by directing a powerful laser beam, whose energy is concentrated in a very narrow (0.005 centimeter-wide) band of infrared wavelengths, on a mixture of uranium isotopes. The infrared laser would be "tuned" to "excite" only atoms of U^{235}, while leaving atoms of other uranium isotopes unaffected. Once excited, the U^{235} atoms develop somewhat different chemical properties, on the basis of which they can be readily separated from the other uranium isotopes. Already the basic research to make this process a practical reality is being supported at an annual level of $40 million.

Lasers are currently used to change the structure and composition of the surfaces of materials on which they are directed. Laser-irradiated surfaces may have new mechanical, chemical, and physical properties that can lead to novel applications. For example, there's at least a possibility that such laser treatment could make some organic materials into a substrate, or base, for photovoltaic cells — devices that convert light directly into electricity. The workshop report says that such an operation could be carried out both "cheaply and on a large scale," once the process is demonstrated.

By selectively changing the chemistry of radioactive spent fuel from nuclear reactors, laser light may be used to separate components of the highly heterogeneous mix. Such processing might pay for itself on the basis of the value of the recycled

Bang But No Fire

Before the pot on your stove begins to boil, small bubbles of water vapor appear on its sides and bottom. And even when the water is at a full boil, the vapor bubbles continue to originate on the bottom and sides, but never in the middle of the container.

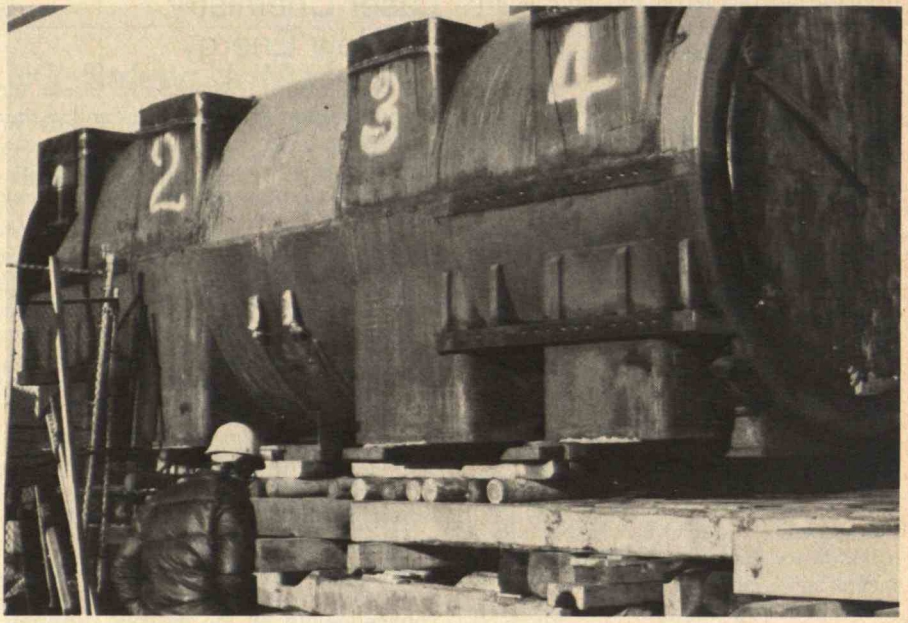
If you could prevent what is called nucleation on the sides and bottom of your pot, you could heat your water to well above 100° C without boiling. Then suddenly it would all happen at once — an explosive transition from liquid to vapor phase — and you would be the victim of a *flameless vapor explosion*.

It won't happen in your kitchen. But such conditions of superheated fluids are possible if two liquids at different temperatures are brought together under just the right conditions. Such conditions are possible, if not probable, if liquefied natural gas is escaping over a water surface.

There is nothing very mysterious about all this to Professor Robert C. Reid of M.I.T. "We know what happens — we don't need to do any more research," he says. An explosion is possible when a liquid is 4 to 6 per cent — no more, no less — above its normal temperature of vaporization. This means that no explosion is possible when LNG first spreads across water; the temperature difference is too great. But "weathering" at the interface will raise the LNG temperature gradually, and a flameless vapor explosion is possible.

"The hazard potential is fairly small," says Professor Reid. Though the change from liquid to vapor is explosively fast ("the strongest function of temperature I've ever seen in a thermodynamic reaction"), only small energies are involved. It's nothing like an explosive chemical reaction. The most significant hazard, says Professor Reid, is that the vapor explosion will help disperse the LNG and in this way increase the potential for more serious mischief. — *J.M.*

materials alone, says the workshop report, to say nothing of its contribution to the serious problem of managing reactor wastes. Some of the components are, indeed, quite costly: americum and cesium, important sources of alpha particles, are priced today at about $1,000 per gram; strontium-90, a source of beta particles, is similarly expensive. If they could be cheaply extracted, these and other materials in nuclear wastes could be profitably recycled. — *J.M.* □



This 328-ton, 200-megawatt alternator, a gift of Con Edison, will power Alcator C, M.I.T.'s latest Tokamak fusion energy research device. The alternator's massive 118-ton rotor, sealed in a hydrogen atmosphere to cut air drag, will be spun to 1,800 r.p.m. by a 2,000 horsepower motor. Once spinning, 3-second-long bursts of 200 megawatts will be tapped from the alternator to develop the magnetic fields inside Alcator C's confinement chamber. (Photo: James C. Rose Jr.)

Moving Toward Fusion: 200 Megawatts and Beam Heat

A 200-million-watt alternator that helped power New York City is now helping further the quest for fusion energy.

The alternator will power the electromagnets of Alcator C, an experimental version of a fusion reactor now under construction at M.I.T.'s Francis Bitter National Magnet Laboratory.

The 200 megawatts of electricity will be used to develop the strong magnetic field needed to contain superheated plasma — a mixture of electrons and hydrogen nuclei ripped apart by high temperatures — within the doughnut-shaped chamber of the reactor.

Since 1972 the M.I.T. Plasma Fusion Center has worked with Alcator A, the predecessor to the current device. In the fall of 1975 the group set a world record for the product of plasma density times confinement time — 10 trillion seconds per cubic centimeter — and then doubled this figure in February, 1977. A value of around 100 trillion seconds per cubic centimeter at 50 million degrees Celsius is needed for the fusion reaction to sustain itself and provide potentially useful energy.

Pleased with their results with Alcator A, the researchers had planned to build a larger device — Alcator B — but its size would have been limited by the 40-megawatt capacity of the Magnet Laboratory's generators. When Consolidated Edison arranged to donate a 200-megawatt alternator, recently replaced by newer equipment for New York City power generation, the plans to build Alcator B were dropped and the Plasma Fusion Center went directly to Alcator C.

Like Alcator A, Alcator C is a Tokamak, a doughnut-shaped chamber inside which the hot plasma is confined. To keep the plasma from colliding with the walls of the chamber and losing heat, the charged plasma particles are held in a magnetic "basket," formed by two magnetic fields. One, the poloidal field, directed around the circumference of the doughnut, results from an electric current induced in the plasma itself by a transformer winding in the center of the doughnut; the second, the toroidal field, at right angles to the poloidal field, is produced by large windings wrapped around the doughnut.

One way to increase the product of density and confinement time is to increase toroidal field strength. In Alcator A a field of 90 kilogauss was used; the new alternator in Alcator C will generate enough power to produce a field of 150 kilogauss. Albert G. Hill, Director of the Plasma Fusion Center, says the builders of Alcator C expect it to produce a density-confinement time product of 100 trillion seconds per cubic centimeter, sufficient for a self-sustaining reaction.

The designers do not expect Alcator C to produce temperatures high enough to sustain fusion, however. So the next stage will be to achieve the necessary temperature of 50 million degrees Celsius. Electric current induced in the plasma provides some heating, in the same fashion as resistance wire does in a toaster, but this heating alone is not enough. The most promising candidate for the needed additional heating is a neutral beam system, in which charged particles are accelerated in an electric field outside the Tokamak and then neutralized so that they may pass through the magnetic basket and collide with the plasma particles, thus boosting the plasma's temperature, hopefully to the needed level.

The Plasma Fusion Center is cautiously optimistic that an upgraded version of Alcator C using neutral beam heating will achieve the conditions needed for self-sustained fusion during the 1980s. But commercial application of such an achievement would still be a good many years away, they say. — *Mark James* □

Energy Policy: Low Price or Real Price

The problem is not that the U.S. lacks an energy policy. Our policy for at least 50 years has been straightforward and unambiguous: to make energy inexpensive.

The problem is that this traditional policy has suddenly become obsolete. Today's debates and controversies represent an effort to understand our new situation and to decide if and how to respond.

To achieve low-cost energy, we've used price controls on interstate natural gas, depletion allowances to reduce the tax burden on fossil fuel producers, and taxes to average the cost of domestic and imported crude — all strategies of price maintenance and subsidy.

Those strategies have worked. The cost of energy in the U.S. has been 30 per cent below the world average, and we have de-

veloped a prosperous industrial system based on profligate energy use.

But suddenly preferred fuels begin to run short, and our supply of low-cost energy can be maintained only at the expense of ever-greater subsidies and our high consumption at the cost of ever-growing imports. So when we say we need a national energy policy, we are simply saying that we must resolve the conflict between low prices and self-sufficiency.

This analysis is the work of Robert E. Hall and Robert S. Pindyck of the M.I.T. Department of Economics, writing in the current issue of *The Public Interest.* They argue that energy supply and demand respond to price as does any other commodity, though the absolute rates of response — what economists call "elasticity" — are in doubt.

Professors Hall and Pindyck conclude that demand falls by about 1 per cent for each 4 per cent increase in price, and supply rises by about 1 per cent for each 5 per cent increase in price. Thus current U.S. policy has resulted in demand "about 8 per cent higher than it would be otherwise, and supply is about 6 per cent lower." This analysis suggests that present low-price policies have the effect of increasing oil imports by a net of about 5 million barrels a day, while our total imports are only about 7 million barrels daily. A striking conclusion: "The import problem is largely of our own making," say Professors Hall and Pindyck.

Professors Hall and Pindyck can conceive of only two strategies, both unappealing, for maintaining depressed energy prices:

☐ Reduced consumption forced by means other than prices — rationing or controls. We're already attempting controls on the speeds and sizes of automobiles, and the attempt is not wholly successful. But there's also a broader argument: "Controls unnecessarily limit people's choices," they say, making people "worse off and less comfortable than they need to be."

☐ Federal subsidies to finance the difference between high world price and low U.S. price. An example are the arrangements now made to tax domestic oil to pay for imported oil. Typical of future subsidies are those being proposed for developers of synthetic fuels, assuring their market even though their operations are uneconomic. Synthetic fuel and shale oil projects "are just not commercially viable," say the economists, "and they would not become viable even if O.P.E.C. were to continue to increase prices at the rate of 10 or even 15 per cent a year for the next ten years."

The alternative, then, is an about-face in U.S. energy policy, and the only road to energy self-sufficiency.

Five strategies are advocated by Professors Hall and Pindyck:

☐ Eliminate all price controls on oil and natural gas. The result will be price increases by 1980 of 25 to 30 per cent on oil and 40 to 50 per cent on gas. Domestic supplies and new discoveries will increase with the greater incentives of higher prices, and consumption will decrease.

☐ Use government subsidies to mitigate the burden of these higher prices on low-income families; a "fuel stamp" plan patterned after today's food stamps is proposed.

☐ Defuse the threat of future O.P.E.C. embargoes with a crude oil reserve, stand-by programs for limiting oil consumption, and stand-by plans for expanding the economy so the nation "will never find itself fighting high inflation at the same time an embargo is imposed."

☐ Try to weaken the O.P.E.C. cartel by making possible competitive purchases from each of its members — for example, a proposal for anonymous auctions of purchase rights attributed to M.I.T.'s Professor Morris Adelman

☐ Let government support energy research agressively, especially work on nonconventional sources. But the government should "keep out of the development and production phases of energy supply."

These policies would lead to a total energy demand by 1980 of the equivalent of only 41 million barrels of oil daily, with domestic resources providing 36 million of this. The price would be about $12.50 per barrel or equivalent, they say. If low-cost policies are continued, demand may be as much as 45 million barrels daily and domestic production only 32 million. And the true cost to the economy, including taxes and subsidies, would be higher than $12.50. — *J.M.* ☐

PLANETARY SCIENCES

The Strange Case of Jupiter's Second Moon

Since Galileo discovered Jupiter's four largest moons in 1610, astronomers have found nine other moons revolving around the giant planet — an arrangement resembling a miniature solar system. Of these satellites, Io, the rocky, planet-sized moon second-nearest to Jupiter, has been the most puzzling following the discovery of a huge cloud of sodium atoms in its orbital path. Data based on recent photographs of Io have led to the development of several hypotheses linking the cloud to previously observed peculiar properties of the moon.

Io, about 400 million miles from earth, reflects more light for its size and distance than any other object in the solar system — about four times as much as our moon. Some scientists have argued that Io shines with unusual brightness when it first emerges from Jupiter's shadow, but this observation remains controversial.

As it revolves around Jupiter, Io seems to act as a switch, controlling the radiation of electrical energy from the planet according to its orbital position. When first observed, this phenomenon was puzzling indeed.

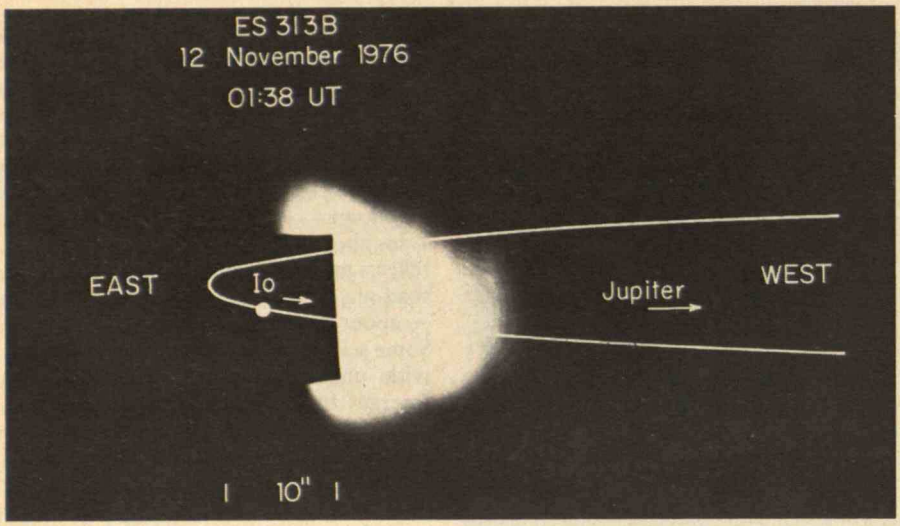
Robert Brown of Harvard's Center for Earth and Planetary Physics added one more oddity in 1972, when he detected an orange-yellow aurora surrounding Io. This glow turned out to be emitted by a banana-shaped cloud of neutral sodium atoms extending along the moon's orbit and moving with it around Jupiter.

The surprises continued in 1973 when *Pioneer 10,* nearing Jupiter, detected a layer of ionized particles above Io's surface — the first ionosphere known on any moon in the solar system — and also detected a long trail of neutral hydrogen atoms forming a partial torus that fills one-third of the moon's orbit, engulfing Io, and dwarfing the sodium cloud. (The existence of an ionosphere, which had been predicted from observations of the sodium cloud, carries the implication that an atmosphere exists on Io. The earth's moon is too small and hot to gravitationally trap an atmosphere; except for faint traces, its free gases long ago expanded and dissipated into space. Io is about the same size — but apparently cool enough to retain an atmosphere.)

It is now believed that the existence and behavior of both the electrical (radio) and optical (cloud) emissions are linked to the fact that Io is engulfed by Jupiter's very powerful magnetic field. This field traps charged particles from cosmic ray interactions and the solar wind, binding them to the planet in doughnut-shaped zones called radiation belts.

Io — immersed in Jupiter's magnetic field — passes through the densest parts of the radiation belts in the planet's equatorial plane. The Jovian magnetic field, which rotates with the planet in its ten-hour period, rushes past Io at a relative ve-

A cloud of neutral sodium, potassium and sulfur atoms accompanies Io in its orbit around Jupiter. Io's brightly reflective surface was masked from view with a tiny bit of black tape on the telescope to make possible this photograph of the cloud. The cloud has revealed remarkable details of the composition of the planet-sized moon. (Photo: Frank Murcray, Center for Earth and Planetary Physics, Harvard University)



locity of 57 km per second; Io orbits Jupiter at only 17 km per second. The relative movement of Io through the planet's magnetic field induces an electrical field around the moon, which attracts charged particles from Jupiter's radiation belts. The energetic particles bombard the moon, causing neutral atoms on Io's surface to "sputter up" into space where they accumulate, forming the observed cloud of neutral atoms.

Remarkable photographs of Io's sodium cloud recently taken by Frank Murcray, a reseacher at Harvard's Center for Earth and Planetary Physics, have provided fresh data with which astronomers have evaluated the dimensions and computed the mean density of the cloud: it is 200,000 kilometers long and 80,000 kilometers high along Io's orbit. The radius of Jupiter is 71,350 km.

The neutral atoms remain in the cloud for about 20 hours, subject only to gravitational forces, until they encounter an electron in the Jovian magnetic field. The atoms then become ionized and are swept toward the planet, where they vanish into the magnetic field. The shape of the cloud has remained constant for over four years, and astronomers calculate that to replace material that escapes from it, 10^8 atoms must be sputtered from each square centimeter of Io's surface each second. Eventually the ions trapped in the planet's magnetic field become neutral again, and their speed, which is equal to that of Jupiter's rotation, may be high enough to permit escape into interplanetary space.

Io's electrically neutral cloud now turns out to contain more than just sodium. Scientists have also detected neutral potassium and sulfur atoms there as well. The complementary characteristics of sodium and sulfur atoms have been extremely useful to astronomers. Sodium atoms are visible when they are in their neutral state and excited by solar photons (and can be photographed with the proper technique); once ionized, they disappear. In contrast, sulfur atoms cannot be seen in the cloud in their neutral state, but sulfur ions give off a characteristic red glow when excited by electrons and are then observable.

Laboratory experiments have confirmed that any atom on the moon's surface is susceptible to sputtering, so it is assumed that the sodium, sulfur, and potassium in the orbital cloud are major components of Io's surface. The search for additional components in the cloud continues on the hypothesis that the composition of the cloud reflects the composition of the moon's surface.

Frozen ammonia has been suggested as another possible surface component — its hydrogen atoms would provide a source of material for the huge hydrogen cloud — but the presence of ammonia frost on Io's surface has not yet been confirmed.

"Io and its emission cloud are telling us more about that moon's surface than we know about any other moon in the solar system other than our own," explained Dr. Brown at the meeting of the American Astronomical Society in Boston last fall. The emitting of neutral and ionized atoms into Jupiter's environment provides an observational resource for ground-based astronomy which did not exist seven years ago, says Dr. Brown — a wholly new approach for studying Jupiter's radiation belt and Io's formation and evolution. — *Odile Disch* □

Some Planetary Connections

To learn more about the planets, look at Earth. And to learn more about Earth, look at its planetary neighbors.

This kind of synergism was a major factor in reports at a Boston meeting of the American Astronomical Society's Division of Planetary Sciences late in the fall. Here are some examples:

The observation that winds in the Martian atmosphere move surface particles just as winds move sand on terrestrial deserts confirms our ideas about the Martian climate and the granulated mineral particles that lie between the rocks on the Martian surface. In part of the southern hemisphere of Mars, between longitude 80° and 120°, spring brings intense local dust storms; they're quite different from the massive episodes which occasionally engulf the planet. A. R. Peterfreund and T. Z. Martin of the University of California at Los Angeles point out that this is an area of high elevation on Mars, where sunlight shines intensely on areas of dark- and light-colored surface material — reasons enough for the existence of winds strong enough to raise the Martian topsoil. The same combination of conditions does not occur elsewhere on Mars; neither do the storms.

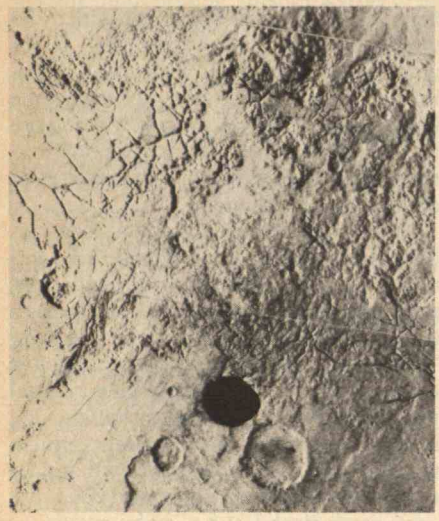
Many channels resembling stream channels carved by water on Earth appear in Viking photographs of Mars, yet there is no evidence of flowing water on the surface of that planet today and little water is retained in today's thin Martian atmosphere. Did Mars once have a lush, water-based life-supporting climate such as Earth now enjoys?

Carl Sagan of Cornell University proposes that even relatively small amounts of water could have performed the erosion we see on Mars if Martian rivers had been protected from evaporation by a layer of ice. Professor Sagan's colleague, D. C. Pieri, says the Martian channels suggest to him the highly variable water erosion processes we associate with the episodic weather of the western U.S.

The greatest floods in the history of the Earth — peak flow rates of over 100,000 cubic meters of water per second — have been recorded in Iceland as volcanic eruptions push hot lava against glacial ice. The resulting flood channels on Iceland look to Carlton C. Allen of the University of Arizona to be quite like some seen on Mars; was there once an episode of massive vulcanism on an ice-covered Martian landscape?

J. A. Cutts and K. R. Blasius offer a dif-

Viking Orbiter I views Mars from 8,500 miles up, showing chaotic terrain near the Martian equator. The planet may have a thin, cool crust stretched over an expanding core and mantle, if its similarity to earth is an indication. The black spot is Phobos, passing about 4,000 miles beneath the spacecraft. (Photo: N.A.S.A.)



ferent explanation for some Martian channels: erosion by lava. Most of us think of flowing lava as building up slowly across a landscape as a river delta builds upon a seascape. But when very large amounts of lava are present the picture might be very different: the lava could dissolve the surface, cutting channels much the way spring run-off cuts its way through icy snowbanks.

Professor Sean C. Solomon of M.I.T. reads planetary history in the evidence of volcanic action on the moon, Mars, and Mercury. He observes two distinct kinds of vulcanism. In one case, lava appears to have been forced through the crust under pressure during phases of cooling and contraction, like fluid squeezed out of a syringe. Other vulcanism seems to have come as planetary cores are heating and expanding, the lava pouring out of cracks in a crust that is no longer strong enough to contain the fluid beneath.

Mercury shows the first kind of vulcanism, Mars the second. So Professor Solomon hypothesizes that Mercury began as a very hot planet, its history dominated by contraction and cooling under an increasingly thick crust. Mars, on the other hand, began life as a relatively cold planet which heated slowly. Expansion tectonics through a thin crust seems to have continued through most of its history.

The unique form of plate tectonics we know on earth is the product of a complicated history, says Professor Solomon. The distinguishing feature of plate tectonics is simultaneous eruption and subduction — new material is constantly added at one side of a plate while old material returns into the mantle at the other. Without exception subduction deep into the mantle occurs only under the oceans. Professor Solomon proposes that the process may be maintained by the gravitational instability of the cooling oceanic plates. No other planet shows evidence of such subduction; rather, other planets seem to have thick continental-type crusts of global extent, incapable of subduction or lateral motion. — *J.M.* □

COMPUTERS

Banking at the Speed of Light — Very Slowly

The seed that looked so fertile in the 1960s — electronic funds transfer (E.F.T.) to substitute computer-generated electronic signals for the millions of bits of paper involved in America's day-to-day financial transactions — has yet to germinate; and it may not do so in the rest of this decade or even in the next.

The reasons are not to be found in technology, or even in government. They rest with the banks, the institutions of commerce, and — most of all — with the millions of people whose checkbooks and credit cards might suddenly become obsolete.

Richard A. Cohn of the Sloan School of Management at M.I.T. has tried to put himself in the place of all these would-be consumers whose lives would be changed by E.F.T. His conclusion, reported to a convocation of Sloan School alumni in the fall: despite the obvious advantages of E.F.T. over which computer-makers and government agencies concerned with banking wax enthusiastic, too many of the consumers have too much to lose.

For banks, E.F.T. offers some hazards as well as the obvious advantages of reduced paperwork. For example, by tradition banks are responsible if they accept forged checks; will the same principles of consumer protection govern E.F.T. transactions, which would be far less visible? If a customer's identification card is reported stolen, how is the bank to know which transactions took place legitimately before the theft and which to the benefit of the thief afterwards? If a $2 transaction appears as a $200 one, is that a machine error or a forgery?

The case against E.F.T. is even stronger when Professor Cohn puts himself in the place of a householder.

It would be a "cashless" society — everyone using a plastic E.F.T. card to pay for purchases. But cash has some important advantages, says Professor Cohn — it's readily accepted, very convenient, and offers great privacy. "The shopkeeper cares that Abraham Lincoln looks right but he doesn't care what you look like at all," Professor Cohn explained. Cash is subject to loss, of course, but the potential loss is limited to the amount of currency involved — not to all the money in an E.F.T. bank account. For these and other reasons an astonishing per capita average of $400 in currency and coin is in people's pockets and safes when the banks close every night.

Credit cards are also indispensable for some transactions in the U.S. today. "Have you ever tried to rent a car without one?" Professor Cohn asked.

When banks entered the credit card business in the 1960s, they thought they were setting the stage for E.F.T. What they did instead, says Professor Cohn, is provide their customers with "a sophisticated education in the value of 'float.' " We've all done it: written checks before the money to cover them is in the checking account, used a credit card to delay by as much as six weeks the moment of reckoning. As the trend toward interest-bearing checking accounts spreads from New England to the rest of the country, such delayed collection tactics will pay cash dividends. All that would be impossible in E.F.T.'s world of banking at the speed of light.

And what is the customer to do if a bill paid by E.F.T. turns out to be wrong? The nearest present analogy is the bill paid in error with a credit card; and lots of credit card holders are rendered uneasy by this comparison.

And then there's the suspicious consumer who wonders who will pay for E.F.T. — the elaborate new hardware and all the "cashless cash registers" that would be found in every store. The question is probably a red herring — given a solution to all the other constraints to E.F.T., the systems will surely pay for themselves.

For some customers, a sales-minded bank might offset some of the disadvantages of E.F.T. by providing some new services. Professor Cohn suggests automatic budgeting — doing with electronics what the householder now does when he distributes the proceeds of his paycheck into little envelopes.

But that's a small benefit, thinks Professor Cohn — and maybe a counterproductive one: it tends to emphasize the cashless character of an E.F.T. world. — *J.M.* □

Electric Power Out of Control

New York City and its unlamented utility, Consolidated Edison Co., lay exposed. A target more vulnerable than anyone realized, it was vanquished by powerful thunderstorms that wandered across Westchester County on the evening of July 13, 1977.

On that warm evening Con Ed was using 5,800 megawatts of power. The utility was generating only 2,500 megawatts on Manhattan itself; the additional power to run New York City's air conditioners, elevators, lights, and subways came from generating stations outside Manhattan. The trouble began when a single lightning strike claimed two lines in a single corridor from the nuclear station at Indian Point. A second lightning strike shortly took two more lines, also in a single corridor, between New York and its sources of supply. Both strikes released "tremendous amounts of energy," says Professor Gerald L. Wilson of M.I.T. A fifth line soon grew so hot from its overload that it literally sagged into the treetops, shorted, and was tripped out.

The operator on duty that night had 2,500 meters in front of him, a vivid image of the sound and fury of Manhattan's millions of consumers, and too little training for dealing with the situation in which he found himself. Indeed, says Professor Wilson, America's power systems "are not designed to require 'operator heroics' like this," and when they do operators are left "to fly by the skin of their teeth." No one knows enough about the dynamics of our interconnected electric power networks to assign their emergencies to the battery of computers which take care of routine management, and no simulator anywhere in the U.S. can train operators for dealing with the emergencies the computers can't handle.

Two lessons to be learned, says Professor Wilson, who has studied the New York case in detail as a member of Con Ed's review board:

☐ Our electric power systems are increasingly vulnerable. The Department of Energy says peak electric loads in the U.S. in July, 1977 — 388,195 megawatts — were higher than ever before, 31,257 megawatts above the previous peak in July, 1976. At the same time, net generating capabilities were 504,814 megawatts, up only 18,416 megawatts from the year before. The theoretical operating reserve was 9.5 per cent in the contiguous 48 states at the time of the 1977 load peaks, 4.7 per cent less than in 1976. Since the beginning of 1976 the reserve had never been lower than about 12 per cent.

Con Ed's situation is especially precarious, says Professor Wilson, because to reduce air pollution, the city has exerted continuing pressure to reduce generating capacity in Manhattan; but the suburbs have refused to give up land for transmission corridors.

☐ The electric utility industry needs new technology to understand and deal with emergency system problems. This is the goal of work in Professor Wilson's M.I.T. Electric Power System Engineering Laboratory, where a prototype computer control system and a simulated electric power grid to test it are now almost in place.

The computer system is programmed with a model of the network of power plants it is to control, and it receives current values for such system variables as currents, voltages, power flows, and boiler pressures and temperatures. From these data the computer will predict and store future values of the same variables; and if — when the future arrives — those variables are not as predicted, the computer will search for the problem and help the operator resolve an emergency before it takes its toll. — *J.M.* ☐

Can the Computer Spot the Spoofer?

Can a computer — by reading handwriting, listening to voices, or analyzing fingerprints — substitute for the thousands of guards who screen millions of workers in the nation's plants and laboratories?

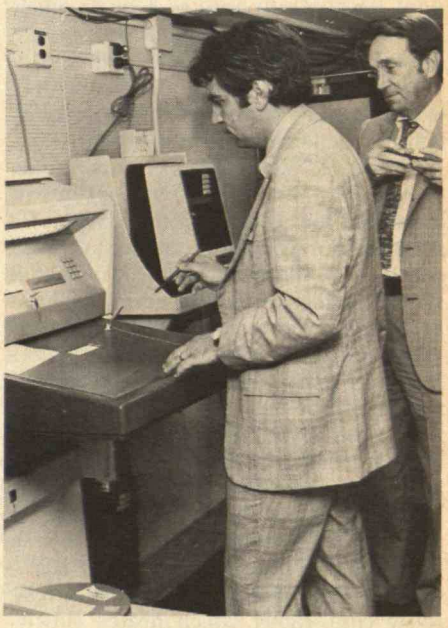
Not yet.

Three systems have been designed for the U.S. Air Force. One compares a signature on file with that given by the worker who seeks to enter. Another compares a four-word phrase spoken by the worker with one of several phrases already on file. The third scans a finger which the worker offers and compares it with a fingerprint on file. In each case, the worker begins by giving his or her name to the computer and then citing the number of the record in the computer's file with which a comparison is to be made.

Engineers at Mitre Corp. were asked to test the three systems, first at Mitre Corp. in Bedford, Mass., and then at Pease Air Force Base. Two kinds of errors were possible: the devices could fail to admit legitimate workers; or they could accept fraudulent identifications provided by would-be "spoofers." The Air Force wanted no more than 1 per cent of the former and no more than 2 per cent of the latter. And the whole process was to take no more than 15 seconds, so that each system could deal with an average of four employees per minute.

No system achieved — or even approached — these goals. Of the three, automatic vocal verification worked best, producing error rates of 1.06 per cent on legitimate workers and 3.26 per cent on "spoofers," with the computer taking just over six seconds to make up its mind and the whole process falling within the 15-second time limit. Handwriting verification was the least satisfactory, with higher error rates (1.88 per cent and 5.63 per cent, respectively) and a decision time of 13.5 seconds.

But the Mitre Corp. engineers, Adolph Fejfar and James W. Myers, conclude that improvements are possible and that "the feasibility of automatically identifying individuals based on their personal characteristics with low error rates has been demonstrated." — *J.M.* ☐



When Congressman Paul Tsongas came home to his eastern Massachusetts district last fall, Kenneth E. McVicar (right), Vice President of Mitre Corp., had him test the Mitre-developed handwriting verification system: a computer compares an individual's handwriting with a sample in its file as a means of automatic personnel identification. Mitre Corp. doesn't tell whether Representative Tsongas was accepted or rejected.

Continued from p. 4

to address directly the nuts and bolts of the colony structure itself, rather than the entire concept. Current and near-term technology lacks nothing required to build the colony itself (e.g., rolling steel plates, welding and bolting them together). In fact, the report has been criticized by N.A.S.A. for being too conservative; these choices were deliberately made so that the feasibility would be less questionable.

As for colony construction: a given worker will be on-station for three months a year and no more than four years. During this 12-month period the maximum background radiation dose he would receive with no shielding is equal to the dosage allowed a present-day radiation worker each year in a 20-year career. The dynamic balance problem would be controlled by careful distribution of fixed mass and by pumping water to compensate for small imbalance — both within the capability of modern control techniques. The atmosphere chosen was similar to that used in Skylab for up to three months. A change to earth-normal atmosphere would have little impact on the design. Our original report discusses these topics in detail and includes the technical data used to reach these decisions.

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Allan J. Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now Assistant Professor of Mathematics and Coordinator of Computer Activities in the Mathematics Department at York College of the City University of New York. Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y., 11451.

A few issues ago, I was pleased to note the survival of the City University of New York; C.U.N.Y. now appears to have a permanent place in the City. On a much smaller scale, I am pleased to note my permanent place in C.U.N.Y.: I have just received tenure.

I have such a nice letter from William Butler that I cannot resist sharing part of it with you: " . . . I would like to express my gratitude and indicate that your column does more than fill up space. I have never attended M.I.T. and for that matter have only a high school diploma. I had long ago given up all hope of ever getting a degree or accomplishing anything. A few years ago I started working on 'Puzzle Corner' problems just for the fun of it, and this, in combination with 'pocket' calculators, has rekindled an old aptitude for mathematics. As a result, I have just enrolled in Roger Williams College (as a freshman) and hope to transfer to Brown University in January. Things are going very well academically; the school has made one mistake: they taught me to play with the computer (see the solution to O/N 2 below)."

Problems

We begin with two problems from previous issues of "Puzzle Corner" that were never solved completely:

NS 10 (formerly **1974 M/A 2**) Akbar Ahmed wants a closed form for $1^1 + 2^2 + \ldots + n^n$.

Since I believe **NS 10** is an open problem in number theory, I also include:

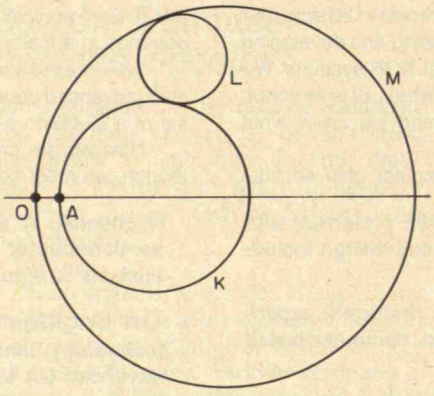
NS 11 (formerly **1974 MAY 3**) Hervé Thiriez is interested in square matrices composed of just 0s and 1s. He feels that any such matrix can have determinant no greater than F_n (F for Fibbonacci), where F_n is defined by $F_1 = F_2 = 1$ and for n at least three $F_n = F_{n-1} + F_{n-2}$. There is an example to show that F_n is actually achieved. Is M. Thiriez correct?

FEB 1 Our first new problem this issue is from Steve Grant, who wants you to place one White King, two White Rooks, and one Black King so that White, who is to move, can mate with any of four moves.

FEB 2 Judith Q. Longyear wants to know: When does $[\sqrt{n}]$ divide n where [ ] is the floor or greatest integer function. More generally, when does $[\sqrt[k]{n}]$ divide n?

FEB 3 Sheldon Razin asks the following coloring question: Given an n-by-n checkerboard and n^2 checkers of n different colors, and given that there are n checkers of each color, is it possible to arrange all the n^2 checkers on the board so that no two checkers of the same color lie in the same row, column, or diagonal? (By diagonal is meant *all* the diagonals, not just the two main diagonals.)

FEB 4 A geometry problem from Harry Zaremba:



In the figure, circle L is tangent to circles K and M, and the shortest distance from its center to the tangent at 0 is 6.5 inches. If the distance between tangents at 0 and A is 1 inch, and the radii of circles K and L are 4 and 2 inches, respectively, what is the radius of circle M? What is the locus of the centers of all circles which are tangent to both circles K and M?

FEB 5 Richard J. Alden has sent us our first "Tick Tack" theoretic problem; he writes: I am currently manufacturing and selling a game I invented called "Tick Tack Math." It has 52 playing cards numbered 1 to 40 with 1 to 12 repeated. The mechanics of the game involve using two-card mathematical combinations to equal upturned single cards from the same deck. Addition, subtraction, division, and multiplication are all acceptable combinations. A single card that matches an upturned card can also be played. The question is: Ignoring knowledge of other upturned, played, or held cards, how many practical ways (including permutations) are there of making each number? I say "practical" because a combination like $2 - 1 = 1$, while mathematically correct, wastes a card and should be omitted from the solution.

Speed Dept.

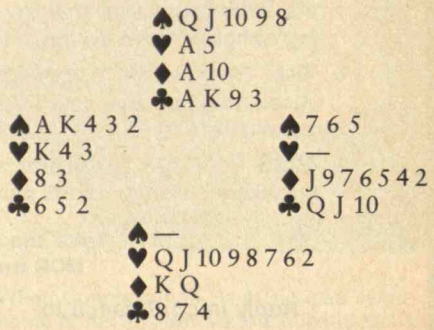
FEB SD1 The man at the left says, "The man in the middle is Tom." The man in the middle says, "I'm Dick." The man at the right says, "The man in the middle is Harry." Tom always tells the truth. Dick sometimes tells the truth. Harry never tells the truth. Who is who?

FEB SD 2 We close with a problem from John Prussing: At the race track, a bettor commented that one-fourth of the horses finished ahead of the horse he bet on and two-thirds of the horses finished behind. Did his horse finish "in the money"?

Solutions

The following solutions are to problems published in "Puzzle Corner" for October/November, 1977:

O/N 1 The original problem as printed read, "Given the following hands, show how South can make six spades":



But there was a misprint; the hands are right, but the contract was supposed to be six hearts with the opening lead a high spade. The surprising part is that many readers were able to deduce this on their own; perhaps next issue I'll try one of the problems encoded. The following is from Brian Boyce:

There is no way that South can make

six spades, but here is how he can make six hearts if the opening lead is ♠A: The winning play strips West of everything but his ♠K and a small trump, then squeezes him out of his ♠K on a lead from his partner. At trick one declarer trumps the ♠A with the ♥6; ♥2 is then led and taken in dummy with ♥5 (West will not go up with the ♥K, since to do so makes the contract a breeze for the declarer). Once in dummy, declarer continues to ruff all his spades using the ♦A and the ♣A and ♣K for transportation. The ♦K is cashed and East is put in the lead with a club. At this point East has two diamonds, South has the ♥Q and ♥J (trump), West has the ♥K and ♥4 (trump), and dummy has the ♥A and a small club. East must lead a diamond; South trumps with the ♥J and now West is in a squeeze. If he plays low, South's ♥J holds the trick and the low club is discarded from dummy, leaving ♥A to win the final trick. If West plays his ♥K at trick 12, declarer overtakes with the ♥A in dummy and wins the final trick with the ♥Q in his hand.

Also solved by Elmer Ingraham, Robert Bart, Frank Klotz, Neil Cohen, Richard Hess, Robert Hatton, William Butler, Gordon Bart, Avi Ornstein, Ed Nordstrom, John Rutherford, George Holderness and the proposer, Winslow H. Hartford.

O/N 2 Find three perfect squares such that the sum of any two is a perfect square.

Several readers (including some familiar names) submitted "proofs" that no such numbers exist. However, William Butler sent in the following (non-empty) list of solutions with the three perfect squares less than 1,000,000:

$\sqrt{A}$	$\sqrt{B}$	$\sqrt{C}$	$\sqrt{A+B}$	$\sqrt{A+C}$	$\sqrt{B+C}$
44	117	240	125	244	267
85	132	720	157	725	732
88	234	480	250	488	534
132	351	720	375	732	801
140	480	693	500	707	843
160	231	792	281	808	825
176	468	960	500	976	1068
240	252	275	348	365	373
480	504	550	696	730	746
720	756	825	1044	1095	1119

Many readers noted that if (A,B,C) is a solution so is (NA, NB, NC) for any integral N. Thus there are infinitely many solutions. Harry Zaremba and Frank Rubin have found several of the above solutions by utilizing Pythagorian triples.

Also solved by Bruce Walker, Neil Cohen, Alan LaVergne, Michael Groves, Harvey Goldman, Edward Lynch, Robert Bart and the proposer, Naomi Markovitz.

O/N 3 Let n be a positive integer. A trapezoidal representation of n is a decomposition of n into a sum of consecutive positive integers — e.g., 15 = 15, 15 = 7 + 8, 15 = 4 + 5 + 6, 15 = 1 + 2 + 3 + 4 + 5. How many distinct trapezoidal representations does n have?

The following solution is from Richard Hess:

Pick a number $n = 2^{\alpha_1} \cdot 3^{\alpha_2} \cdot 5^{\alpha_3} \cdot 7^{\alpha_4} \cdot \ldots \cdot P_i^{\alpha_i}$, where P_i is its largest prime factor of n. Let $B = 3^{\alpha_2} \cdot \ldots \cdot P_i^{\alpha_i}$; n can be expressed as the sum of k consecutive integers if:

for odd k, k divides n, so k divides;

for even k, n/k is half an odd integer, so $k = 2^{\alpha_1+1} r$ where r divides B.

Thus the number of odd decompositions equals the number of factors of B, namely $(\alpha_2 + 1)(\alpha_3 + 1) \ldots (\alpha_i + 1)$. The number of even decompositions is also the number of factors of B. The total number of decompositions is therefore $2(\alpha_2 + 1)(\alpha_3 + 1) \ldots (\alpha_i + 1)$. Unfortunately, however, this number includes decompositions which start with nonpositive numbers. Surprisingly, though, exactly half of these decompositions have all positive numbers. Thus, the number of trapezoidal representations of n is $(\alpha_2 + 1)(\alpha_3 + 1) \ldots (\alpha_i + 1)$. More precisely, let N be the number of terms in the trapezoidal representation; and let A = n/N be the average value of a term (if N is even, A will be half-integer). In order for there to be all positive terms in the trapezoidal representation, the smallest one must be positive:

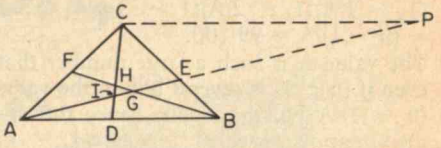
$S = A - (N - 1) / 2 > 0 \Rightarrow 2A - N > -1 \Rightarrow 2A - N \geq 0$.

If N is odd we may write the condition as $2n/D - D \geq 0$, where D = N (the odd divisor). If N is even, 2A is an odd divisor (= D), and we can write $D - 2n/D \geq 0$, where D = 2A is an odd divisor. The expression $\pm (2n/D - D)$ is the difference of an even number (2n/D) and an odd number (D) and can therefore never be zero. Thus if we consider each odd divisor of n we generate all the trapezoidal representations, one for each odd divisor as follows:

$2n/D - D > 0 \Rightarrow$ number of terms = D; average term = n/D.

$2n/D - D < 0 \Rightarrow$ number of terms = 2n/D; average term = D/2.

Also solved by William Butler, Edward Lynch, Winslow Hartford, Frank Rubin, Neil Cohen, Judith Longyear, Michael Kennedy, Robert Bart, R. Robinson Rowe, Frank Klotz, Michael Jung, and the proposer, Naomi Markovitz.



O/N 4 Given triangle ABC such that AB/AD = BC/BE = CA/CF = n. Draw AE, BF, and CD intersecting at points G, H, and I. What is the area of triangle GHI?

The following solution is from Frederic Vose:

If AB/AD = BC/BE = CA/CF = n, then triangles ABC and ADC have common altitude bases ~ n and triangles ADC and ADI have common altitude bases ~CD/ID. Construct CP parallel to AB, extending AE to P: IC/ED = CP/AD (since triangle AID ~ triangle CPI), and CE/BE = CP/AB (since triangle ABE ~ triangle CPE). Then: CD/ID = IC/ID + 1 = CE/BE · AB/AD + 1 = (BC/BE − 1) AB/AD + 1 = n (n − 1) + 1. Triangle AIC has the area of triangle ABC multiplied by $1/n(1 - 1/[n(n - 1) + 1])$; triangles ABG and CBH have the same area as triangle AIC. Triangle GHI has the area of triangle ABC multiplied by $[1 - 3/n(1 - 1/[n(n - 1) + 1])] = (n - 2)^2/[n(n - 1) + 1]$ · area ABC.

Emmet Duffy and the proposer, Harold Heins, calculated several additional areas. There were also solutions from Steven Conrad, Harry Zaremba, I. L. Hopkins, Naomi Markovitz, Timothy Maloney, Sam McCluney, Jacob Pomerantz, Neil Hopkins, Neil Cohen, R. Robinson Rowe, William Butler, Richard Hess, and Robert Bart.

O/N 5 If a bridge foursome plays one hand every five minutes, how long will they have to play to have a 1-per-cent chance of a hand repeating? (We require that each person has the same hand that he or she did on any previous deal; but the two deals in question need not be consecutive.)

I particularly enjoyed this problem. Emmet Duffy's response met all the conditions for an ideal solution: accuracy, legibility, ease of typesetting, and use of the same method I chose. Seriously, the first three criteria are the ones I use in addition to favoring unfamiliar respondents. Mr. Duffy's solution follows:

The number of bridge hands is given by $52!/13! \cdot 13! \cdot 13! \cdot 13!$, which is equal to $5.3644738 \cdot 10^{28}$. Call this value A. If the probability is 1/100 that a hand will repeat in n hands, then the probability is

99/100 that no hand will repeat in n hands. The probability that the second hand differs from the first is $(A - 1)/A$. The probability that the third hand differs from the first and second is $(A - 2)/A$. If the probability is 99/100 that n hands are all different, then:

$[(A - 1)/A][(A - 2)/A][(A - 3)/A] \ldots [A - (n - 1)]/A = 99/100$

$(1 - 1/A)(1 - 2/A)(1 - 3/A) \ldots 1 - (n - 1)/A = 99/100.$

The value A is such a large number that even if $(n - 1)$ is several billion the value $(n - 1)/A$ will be small; hence the approximation, natural log of $(1 - x) = - x$, can be used. Taking the natural log:

$- 1/A \cdot - 2/A \cdot - 3/A \ldots - (n - 1)/A = \log 99 - \log 100;$

$[1 + 2 + 3 + \ldots + (n - 1)]/A = \log 100 - \log 99 = 0.01005034;$

Summing the arithmetic progression:

$[n(n - 1)]/2A = 0.01005034;$

$n(n - 1) = 0.02010068 \cdot 5.3644738 \cdot 10^{28} = 10.782957 \cdot 10^{26}.$

The number n will be so large that as an approximation $(n - 1) = n$. Taking the square root, $n = 3.2837413 \cdot 10^{13}$. Let the year equal 365 + 97/400 days. If a hand is played every five minutes, there will be 288 hands per day and $1.0518984 \cdot 10^5$ per year. Dividing this figure into n results in $3.1217285 \cdot 10^8$ years.

Also solved by Robert Bart, R. Robinson Rowe, Harry Zaremba, Winslow Hartford, Avi Ornstein, Frank Rubin, Michael Kennedy, Timothy Maloney, Neil Cohen, Richard Hess, and the proposer, William J. Butler, Jr.

1 P-K4 K any
2 Q-N4

2 . . . K to KB file
3 Q-Q7

3 . . . K to first rank	3 . . . K elsewhere
4 P-QN3	4 P-Q4
If K on B1:	If K on N3:
5 B-N2	5 Q-K7
If K on N1:	If K on B3:
5 B-B4 (ch)	5 B-QB4
If K on R1:	If K on R4:
5 B-N2 (ch)	5 Q-KN7
	If K on R5:
	5 Q-R3 (mate)
	If K on K5:
	5 B-Q3 (mate)

2 . . . K elsewhere
3 Q-N7

3 . . . K to first rank	3 . . . K elsewhere
4 B-N5	4 P-Q4
If K on Q1:	If K on R4:
5 Q-Q7 (mate)	5 Q-QN7
If K on B1:	If K on N5:
5 B-B6	5 Q-QN7 (ch)
If K on N1:	If K on N3:
5 B-R6	5 Q-Q7
If K on R1:	If K on B3:
5 B-R6	5 B-KB4
	If K on Q3:
	5 B-KB4 (ch)
	If K on K3:
	5 B-QN5

Better Late Than Never

MAY 1 Jacob Bergmann submitted the following improvement which shows that mate can be forced in six moves; Mr. Bergmann attributes the solution to Henry Dudeney in the 1890s. It's shown in the box above, omitting the sixth checkmating move.

PERM 2 John Podolsky has responded.

1976 O/N Edward E. Lynch has responded.

Y1977 Scott Byron has responded.

1977 JUN 4 Tom Jenkins, *Technology Review*'s proofreader, notes that the last line of the solution (top of page 16, December) should have been:

16 0 0 0 355/113 ADD

J/A 1 Eric Feldstein and Raymond Ortman have responded.

J/A 2 Nadir Godrej and Robert Bishop have responded.

J/A 5 Nadir Godrej has responded.

Proposers' Solutions to Speed Dept.

FEB SD 1 From left to right: Dick, Harry, and Tom.

FEB SD 2 No; the horse was fourth out of 12.

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Colder Later This Year

Every fall, Hurd C. Willett, Professor of Meteorology, Emeritus, turns his long-range forecasting talents to the task of bringing good — or bad — news about the coming winter weather. This year the news was mixed: fall and early winter will be cold and snowy in the Midwest; then a "substantial break" in the pattern will occur, bringing "significantly colder" temperatures and heavier snowfall to the East. Cold, yes, but not so bad as 1976-77.

Professor Willett calls this year's one of his "most confident" predictions. He's made a lifelong study of the influence of solar activity on weather, drawing on data going far back into history. Warm and dry weather is associated with periods of rising sunspot activity, he says, and cool and wet weather with periods of declining activity — which is where we are now. □

Solar Heat in the Ceiling

The Department of Architecture is about to move into a new classroom and studio building — an experimental, 900-square-foot bungalow heated 85 per cent by the sun. It's a "passive" solar heating system, the first of its kind anywhere, says its designer, Timothy E. Johnson, Research Associate in the Department: no moving parts, and no circulating water or chemicals.

Two elements collect and store heat for the building:

□ South-facing windows are of a new type which admits 80 per cent as much sunlight as conventional double windows but loses only 25 per cent as much heat at night.

□ Thin ceiling tiles have chemical cores which store the day's heat and release it at night. There are reflecting louvers in the south-facing windows to bring sunlight onto the ceiling tiles from inside, and the sun itself warms them from the outside.

Mr. Johnson says that this "passive" approach — no costly pumps, fans, and other equipment — means that the extra cost of solar heating will be returned in ten years instead of 30. □

Sensing Balance

Like optical illusions, errors in our sensing of gravity, acceleration, and inertial change claim a significant toll of illness, injury, and death. The pilot of an aircraft catapulted from a carrier, pressed hard against the back of his seat, may assume that his aircraft is tilted upward; he adjusts the controls accordingly and plunges into the sea. Aircraft passengers have similar experiences when their plane is in a holding pattern; changes in pitch and direction are undetected or misunderstood. Some 10 per cent of U.S. Army helicopter accidents are apparently caused by such "orientation errors."

Beginning nearly a decade ago, Professor Lawrence R. Young and his associates have been trying to understand such issues, and their effort has led them into ever-more sophisticated studies of the system in the inner ear by which we orient ourselves in space.

Now, in a new Biomedical Engineering Center for Clinical Instrumentation, this work — involving new uses of microprocessors — is yielding a set of relatively simple instruments to help doctors diagnose the causes of dizziness, disequilibrium, and related disorders; and Professor Young thinks it will also lead to cheaper and better flight simulators for pilot training. "The current practice is to teach the pilot to totally ignore his vestibular system, to rely only on the instruments," says Professor Young. "But in an emergency it's hard to fight nature. I would rather have pilots recognize and understand the illusions." □

Studying the Life of a Cell with a Molecule Microscope

The human eye sees a surface by focusing light that passes through it or is reflected from it; the same principles are involved in conventional microscopes. An electron microscope examines a surface by focusing high-energy electrons reflected from it. Now enter the molecule microscope, which "sees" a cell membrane by focusing molecules that have passed through or desorbed from the membrane.

Other microscopes can discern only the physical features of a cell. But a molecule microscope can map the biological and chemical properties of a cell. You see where the cell takes in material or excretes it. Suppose, for example, a slice of wood is mounted in the vacuum chamber of a molecule microscope and the microscope's detector is tuned to recognize only water molecules. As the detector scans the wood it sends a picture signal to the display. At points where there is water coming out of the wood the display registers a bright spot. After the scan is complete the display shows which areas of the wood's tissue serve to pass water.

John G. King, Director of M.I.T.'s Molecular Beam Laboratory, is working with several students on various aspects of molecule microscopy; he describes the present status of the work as like that of a child, having just learned to use a hammer and nails, wishing to build a skyscraper. Joseph Jarrell, a graduate student, is testing a molecule microscope with a resolution of 10^{-5} meters, compared to a common light microscope resolution of 10^{-6} meters. Andrew Sachere, an M.I.T. undergraduate, is developing a more efficient detector to improve resolution. Dusan Lysy has just finished his doctorate thesis on the desorbtion properties of various biological surfaces; when one knows the characteristics with which biological surfaces release coatings of molecules, such as water, it is possible to recognize a surface by the way molecules desorb from it at various temperatures.

Though the molecule microscope has a long way to go, Dr. King and his students are confident of its future importance as a way to look at the biological structure of entire cells, enabling scientists to discover how the cell works as an entire system. — *Claude J. von Roesgen, M.I.T. '79* □

Electrifying the Millponds

Can the picturesque millponds left from an earlier era in countless New England villages be reharnessed for their electric potential?

The Corps of Engineers counts 2,866 dams in New England, of which 207 are used to produce power and 1,029 are sources of water for urban supplies and irrigation or for flood control. The water behind the rest is an untrapped asset, and the Corps of Engineers says it contains potential to double New England's generating capacity. E.R.D.A. is more conservative, suggesting a fuel-free bonus of 18 per cent of current production.

Henry B. Brainerd, who retired from the Charles S. Draper Laboratory a year ago, responds to these figures with a suggestion. "What is needed," he writes in a letter to *Astronautics and Aeronautics* Magazine, "is standardized generating units produced in quantity, easily installed, and arranged for automatic operation and minimal maintenance. . . . Automatic regulation of flow at each dam to hold it to a minimum when power demand is low could also be beneficial if it could be made cost-effective," he says. □

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Computer Seeks Uranium

Peter L. Briggs, a graduate student in earth and planetary sciences at M.I.T., showed a computer the map of uranium deposits in the southern half of the Colorado plateau; he listed 14 features which seemed to be related to the known occurrences of uranium there; the computer recorded these and their locations with respect to the uranium.

Then Mr. Briggs showed the computer a map of the northern half of the Colorado plateau; given the geological features on that map, he asked, where should we look for uranium? In its reply, the computer correctly identified 83 per cent of the known uranium-producing sites and 74 per cent of the uranium-barren sites.

It's the beginning, thinks Mr. Briggs, of a new ore-finding method based on a computer's ability to recognize patterns. Such pattern-recognition programs are already in regular use to analyze blood samples and satellite photographs. □

How Viking May Have Tested Relativity

The most accurate test ever of Einstein's theory of general relativity is now in progress at M.I.T. Just as the Viking landers, and orbiters, activity peaked, the sun passed directly between Mars and the earth. General relativity predicts that radio signals are slowed when they pass near the sun; if so, Viking's signals, which normally took some 42 minutes to reach earth (500 million miles), would have been delayed in late November by perhaps 0.0002 second.

The Viking project's radio communications system was so precise that the round-trip time of radio signals could be measured with errors no larger than 0.0000001 second. The experiment is potentially ten times more accurate than any previous test of general relativity, and Irwin I. Shapiro, Professor of Geophysics and Physics, is busy sifting Viking data for the 0.0002 second delay. □

To Halley's Comet by Ion Accelerator

A giant unmanned spacecraft, built in orbit with equipment brought up by the space shuttle, turns on its engines and begins to slowly accelerate away from the earth on its way to a 1986 rendezvous with Halley's Comet. The ship has an array of solar power cells 80 meters on a side and an engine that rips electrons off atoms to make ions and then accelerates the ions to speeds over ten kilometers a second.

For years it has been thought that a comet rendezvous mission would be powered by solar sails, enormous sheets of aluminized plastic more than a kilometer on a side and thinner than the plastic wrap you use in your kitchen. The sails would collect power from the tiny pressure of sunlight, continuously moving the mission, like a schooner plying the oceans of space, with only about 0.005 the force of earth's gravity.

An ion engine, on the other hand, would be more like a conventional rocket. Solar power would provide electricity to strip electrons from atoms of fuel, turning the atoms into ions which can be accelerated to high speeds. The acceleration would provide a force large compared with that from solar sails — perhaps a tenth or a hundredth the force of earth's gravity, according to Oscar Orringer, Associate Director of the Aeroelastics and Structures Research Laboratory at M.I.T.

Why has N.A.S.A. opted for the ion drive instead of solar sails?

First, the higher acceleration of the ion drive is an advantage, and it can be turned on and off — which would not be possible with the sails. Second, the power of sunlight would decrease as the spacecraft headed for the outer planets, so a sail would lose power. And, most important, the technology of ion drives is much more familiar. How do you fold a square kilometer of thin aluminized plastic into the shuttle without creasing it in the wrong places? asks Dr. Orringer. And once you have it in orbit, how do you unfold it? The pressure of sunlight would deform an unsupported sheet, but how do you support it? There are just too many new and untried things.

The technology of ion drive is now state-of-the-art, and development is only a question of time and money. But if development is not started now, according to A. Thomas Young, Planetary Science Director at N.A.S.A., there will be no Halley's Comet rendezvous, and an opportunity that will not occur again in this century will be missed. He hopes to see the spacecraft ready to go by the middle of 1982. — *J. D. Simonoff, M.I.T. '78* □

Surviving in a complex world•The slot machine theory•Strengths, frailties, and shared water

As one of the world's largest industrial organizations, we know we can retain our franchise to do business around the world only as long as the job we do is effective, useful, and important in serving people's needs. And only as long as people realize this.

We have to be sensitively concerned with society's problems and hopes, even if only in our own self-interest, because we are intricately involved in the complexities of this increasingly complex world. And we learned a long time ago that the success of a company depends in part on factors that don't appear in the balance sheet.

We believe the United States has entered a period in which people will increasingly want to know more about a corporation than just the quality of its products and services. We believe that more and more people are going to want to know something of the value patterns and basic convictions of the individuals who run a corporation, the individuals who in many ways set the tone for the entire company and who inevitably exert an impact on society.

Which is to say that what people think of a company has a lot to do with whether or not it makes money, or indeed even survives. A company such as ours certainly cannot plead that it exists solely to sell goods and services and to earn a profit. No such company can any longer take for granted even the right to be in business, because that right could be withdrawn any time such action seemed desirable to enough people.

In the words of a former chairman of Mobil, "No business is truly safe unless it serves its customers better than they could serve themselves, persuades them that it is doing so, and retains their goodwill in the process. One can't be too sure how long corporations would retain their present opportunities to operate at a profit if making money were their sole contribution to society."

Mobil tries to be a good employer, a good supplier, a good customer, a good investment, and a socially conscious organization. We try also to be responsive to the aspirations and legitimate needs of minorities and others of the disadvantaged, to environmental problems, and to a host of other concerns. And we would not argue that this is undiluted altruism.

Clearly, however, a corporation labors under severe handicaps in trying to establish itself as a good citizen. The criteria are frequently hazy and subject to sharp differences of opinion among contending groups. There are, and probably always will be, those who find something sinister in the very existence of a large corporation—particularly, we suppose, a large oil company.

Many people view the modern corporation as a glorified slot machine created and operated by glassy-eyed, flint-hearted bankers, lawyers, and technocrats. All this quite naturally plays into the hands of political demagogues, who realize that relatively few of the general public have the information necessary to make value judgments where complex issues of economics and technology are involved.

Since many politicians' concept of infinity extends only to the next election, it is probably unrealistic to expect them to behave otherwise. But this compounds the problems of more-responsible politicians and of businesses that are laboring to persuade the public by concrete example that they are fair, conscientious, public-spirited, and socially desirable.

This is not to argue that all businesses—or any of them, for that matter—are perfect. Far from it. But the individuals who run businesses did not resign from the human race when they became corporate managers. And the individuals who devote themselves in such large measure to denouncing our industrial civilization do not thereby acquire halos. We all have our frailties.

Having said that, we have to add that we are mystified that so many of our critics can forget that we have to breathe the same air they breathe, drink the same water they drink, live in the same towns and cities they live in, enjoy the same beaches they enjoy, and exist in the same society in which they exist. How could we possibly be oblivious to the quality of life or to the aspirations of an upwardly mobile society?

We think the public is ill-served by a situation in which private business and its critics find themselves in a running battle of charge and counter-charge. In our view, our country needs and is entitled to a calmer, more constructive dialogue to delineate more sharply the most productive relationship between business and society. That way, we believe, lies the best hope for the future.

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Question two	**Have you developed a machine whose use would expand the market for the basic material you supply, but you don't want to go into machine building?**	**YES** ___ **NO**
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CUSTOMER	PRODUCT	QUANTITY TO DATE	ARTISAN'S CONTRIBUTION	
			Total Manufacturing Responsibility	Special Services
Chemical Manufacturer	Textile Printing Equipment – Auxiliary	350	Yes	• Console and automatic controls for instruments, solenoid valves, steam, air, solvents, etc. • Shipped direct to Customer's customers.
Inventor & Consultant	Food Analyzer for Uniform Quality Control	240	Yes	• Re-designed to sanitary code and OSHA standards. • Designed, improved, manufactured all electronic circuits. • Marketing service – provided field service and parts back-up on a continuing basis.
Bulk Chemical Producer	Expandable Polystyrene Production Equipment for Packaging Use	380	Yes	• Research and development of concept – working with customer engineers. • Designed machine to meet concept parameters. • Motor controls and interlocks. • Marketing service.
Manufacturer	High Vacuum Coating Equipment for Metallurgy Application	5	Yes	• Verification of stress calculations. • Electrical controls and instrument wiring. • Prototype microprocessor for increasing production and quality at reduced cost.
Medical Team	Tissue Homogenizer for Medical Research	100	Yes	• ASME code, Sec. VIII, for 1500 psi design pressure (nitrogen containment).
Machinery Importer	Vacuum Lifters for Material Handling	250	Yes	• Low vacuum generating cylinder. • Electronic leak detector and safety device.